Spinal Cord

Functions of the Cord

- **Conduction**
  - contains bundles of nerve fibers that conduct information up and down the cord
- **Locomotion-** control of repetitive coordinated contractions of several muscle groups in the limb
  - consist of central pattern generators- CPG are neural circuits that produce self-sustaining patterns of behavior without sensory input (Examples: locomotion, respiration, mastication).

Gross Anatomy

- extends from foramen magnum to L1
- averages 1.8 cm thick and 45 cm long
- gives rise to 31 pairs of spinal nerves
- divided into cervical, thoracic, lumbar, and sacral regions

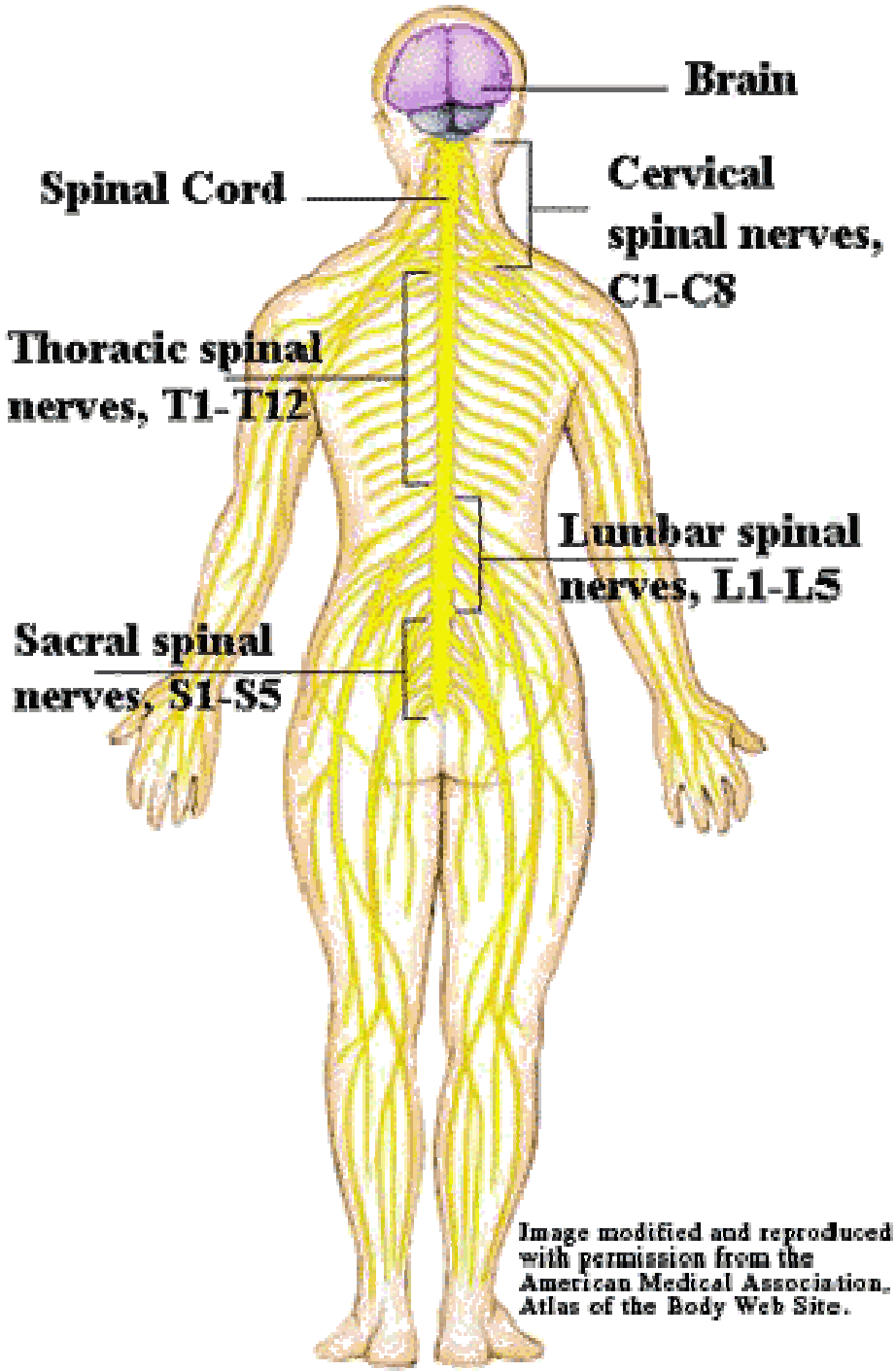
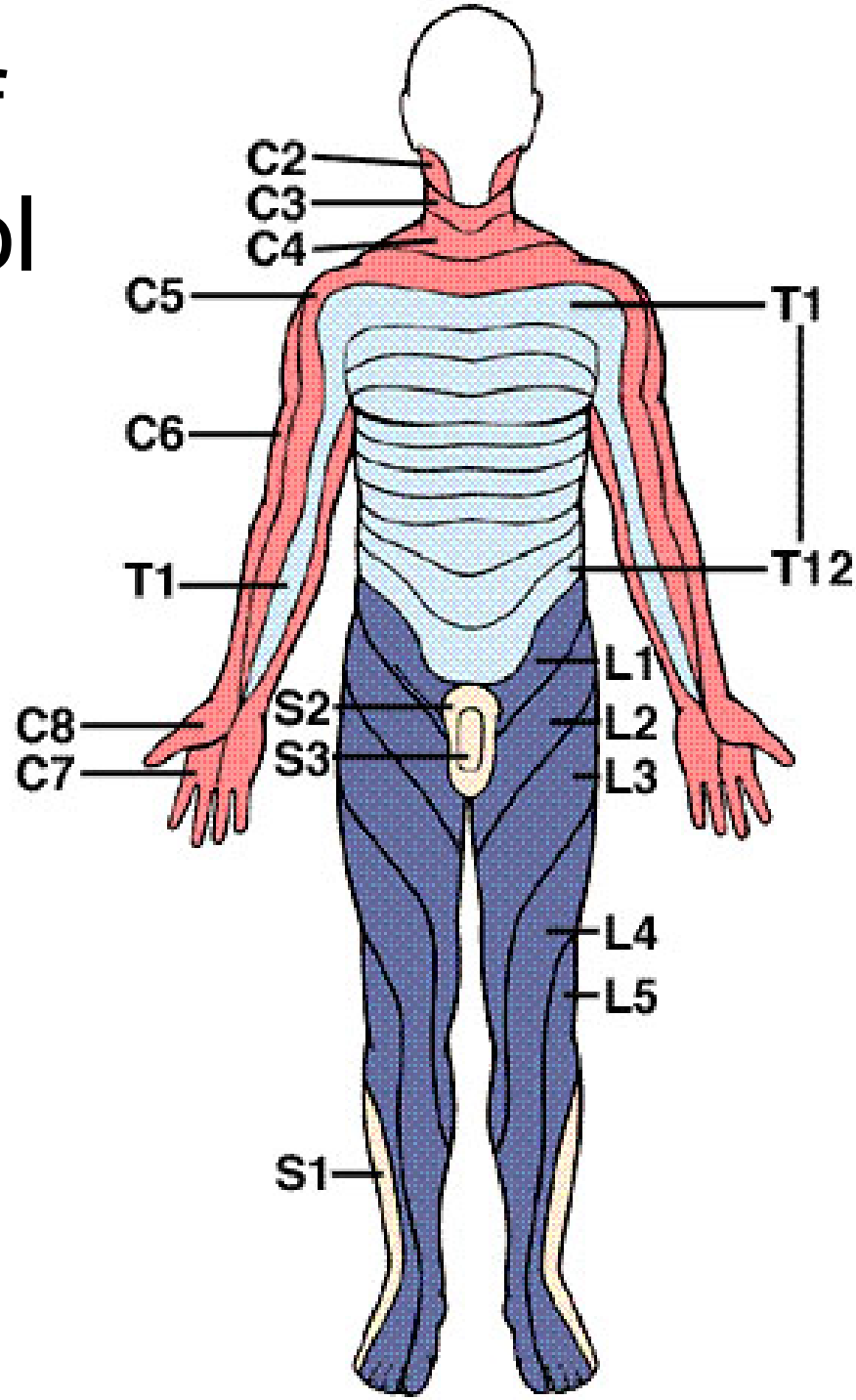


Image modified and reproduced with permission from the American Medical Association, Atlas of the Body Web Site.

Different Levels of Spinal Cord Control

- **Cervical**- neck, shoulder, outer arms, hand
- **Thoracic**-inner arm, chest, abdomen
- **lumbar**- front of leg and foot
- **Sacra**l- back of leg and foot



Gross Anatomy

- **cervical enlargement-** (C3-T2) gives rise to nerves of the upper limb
- **lumbar sacral enlargement** (T9-T12)- give rise to nerves of the pelvic region and lower limbs

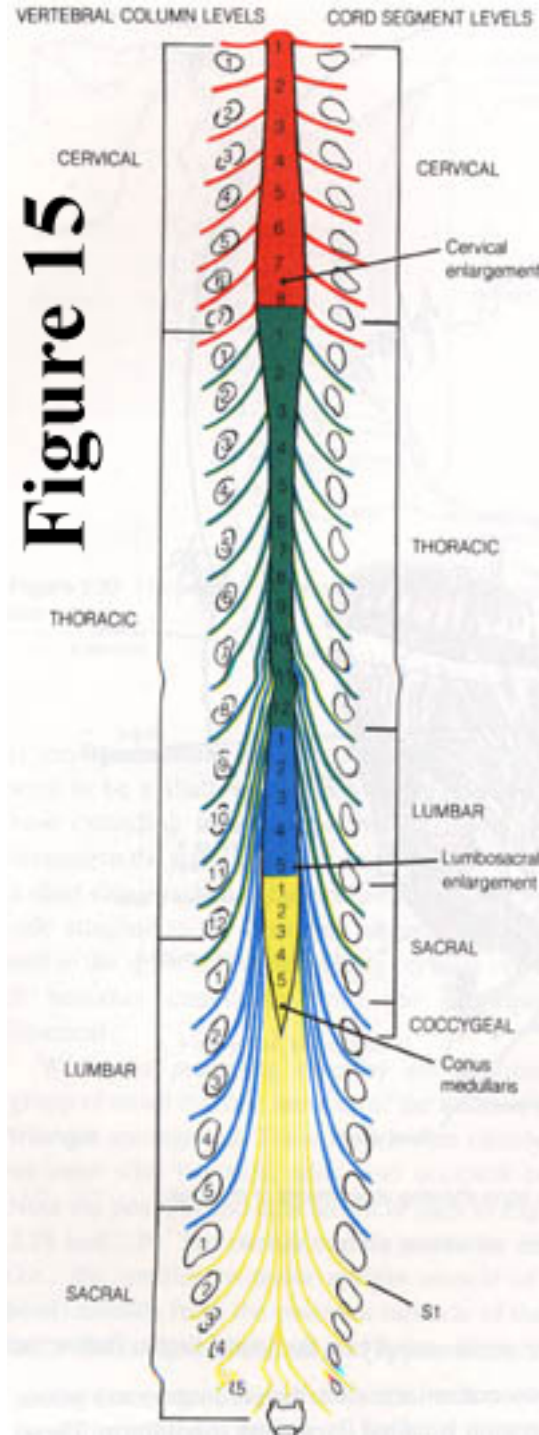
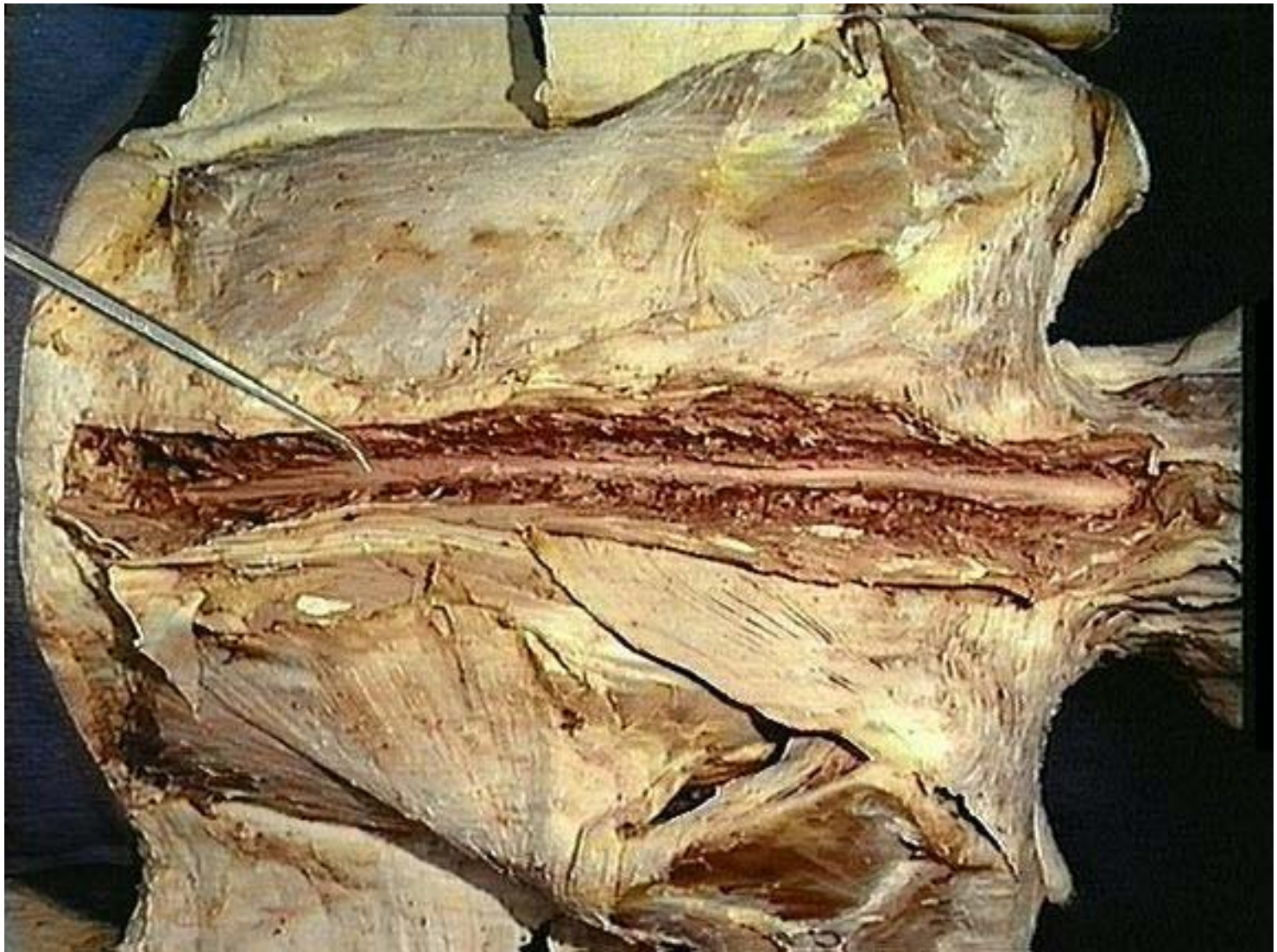


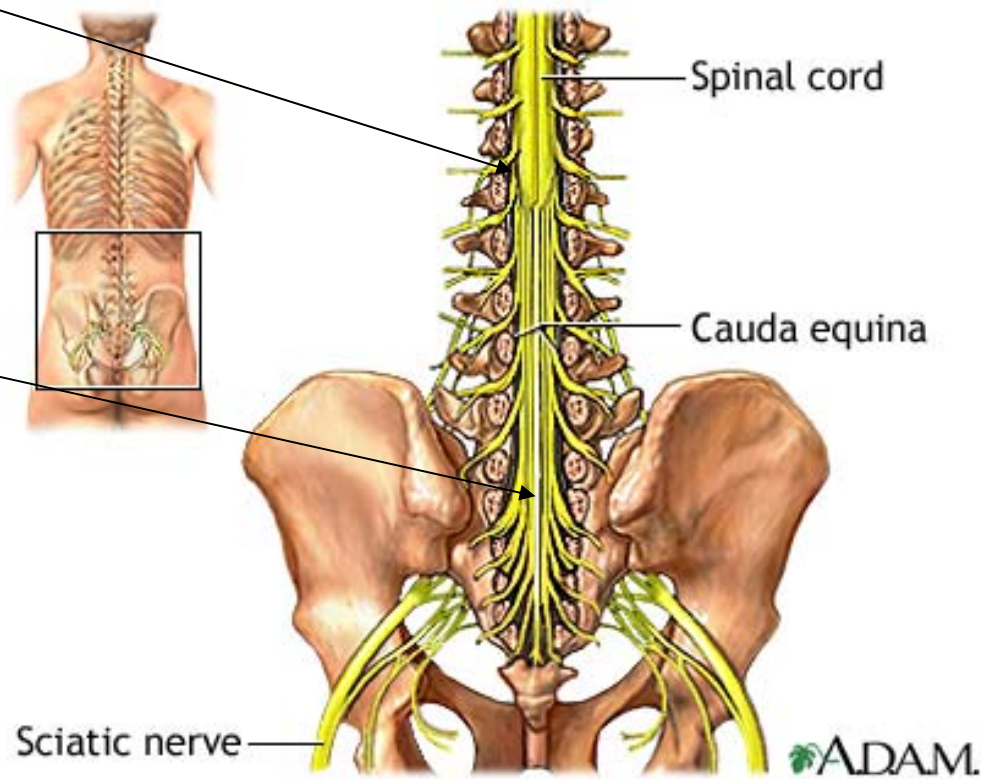
Figure 15

Cervical & Lumbar Enlargement

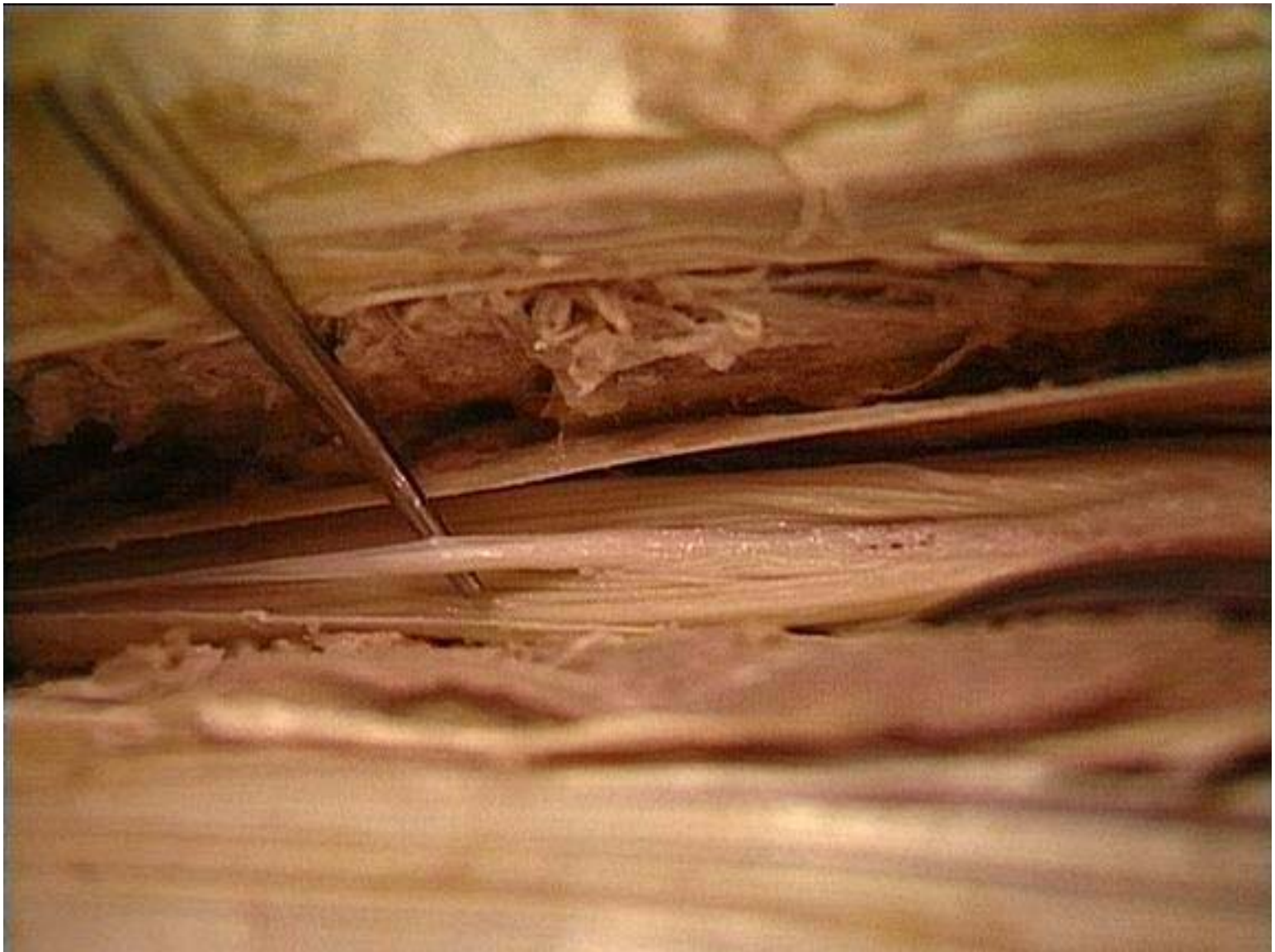


Gross Anatomy

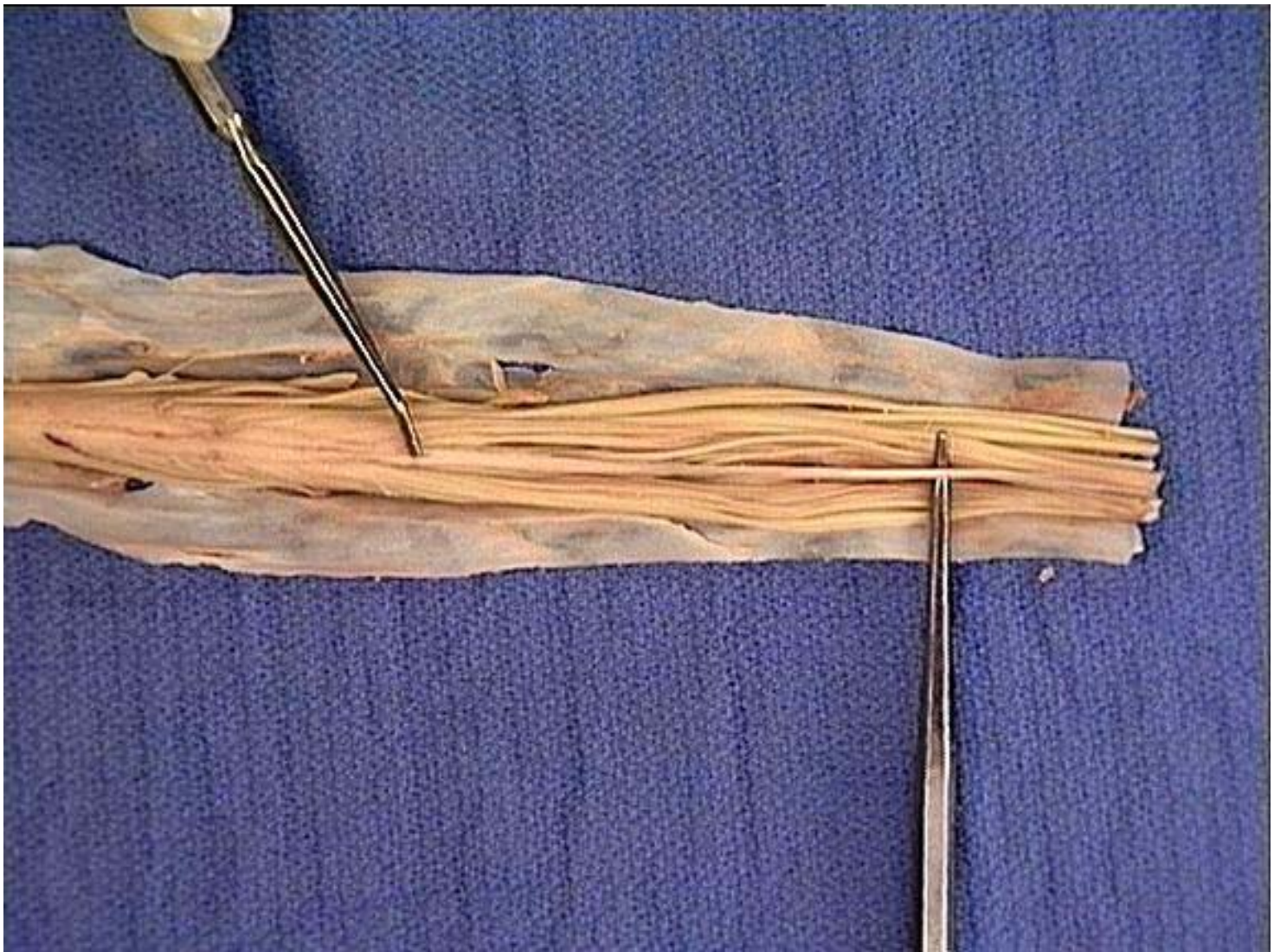
- **medullary cone-** taper of the distal cord
- **cauda equina-** bundle of nerves originating from the lumbar and sacral cord
- **Terminal filum-** fibrous continuation of the cord beyond the medullary cone
  - consists of **pia mater** and **neuroglial elements**.
  - s a vestige of the spinal cord of the **embryonic tail**, but in the adult it has **no functional significance**.



Cauda Equina and Terminal Filum



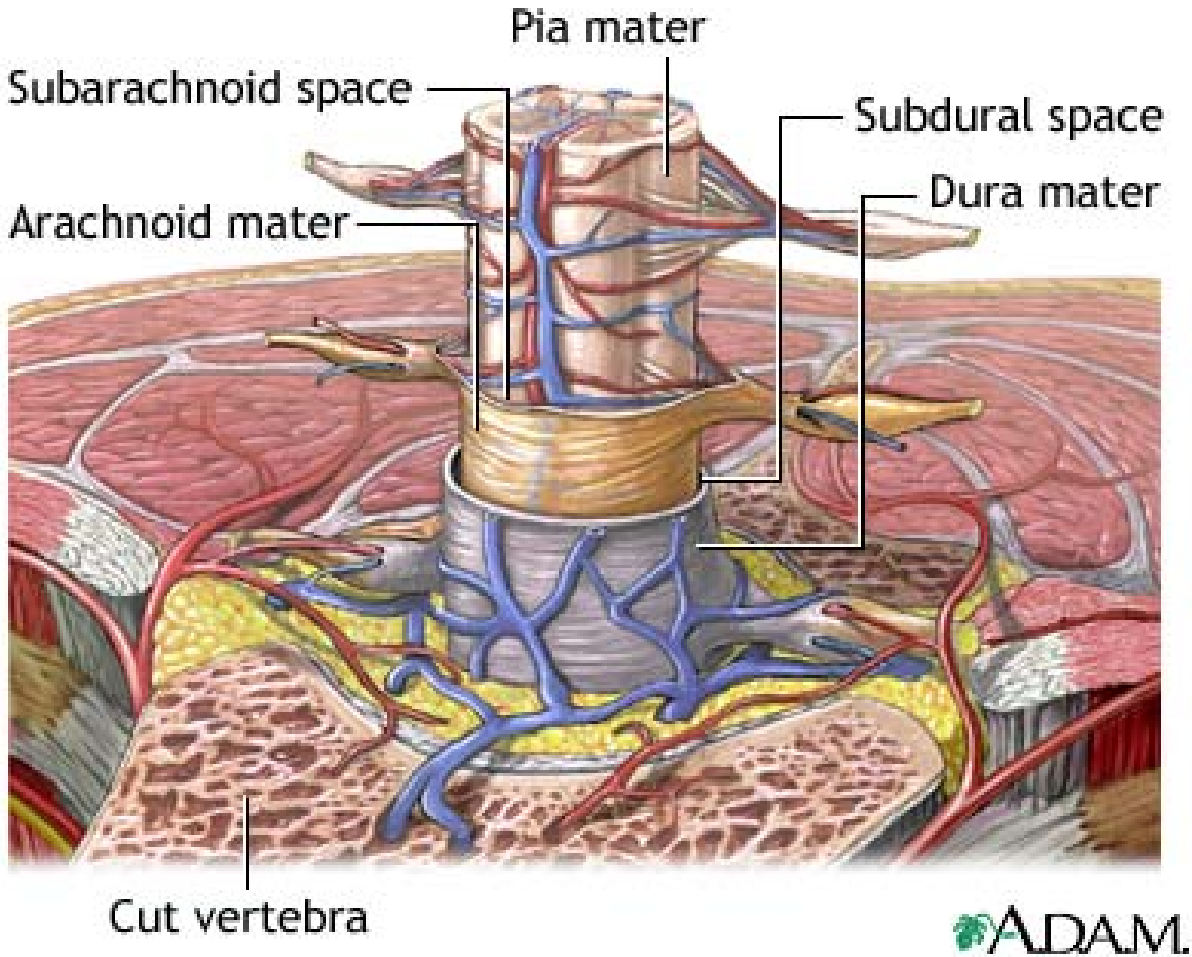
Cauda equina with conus medularis and terminal filum

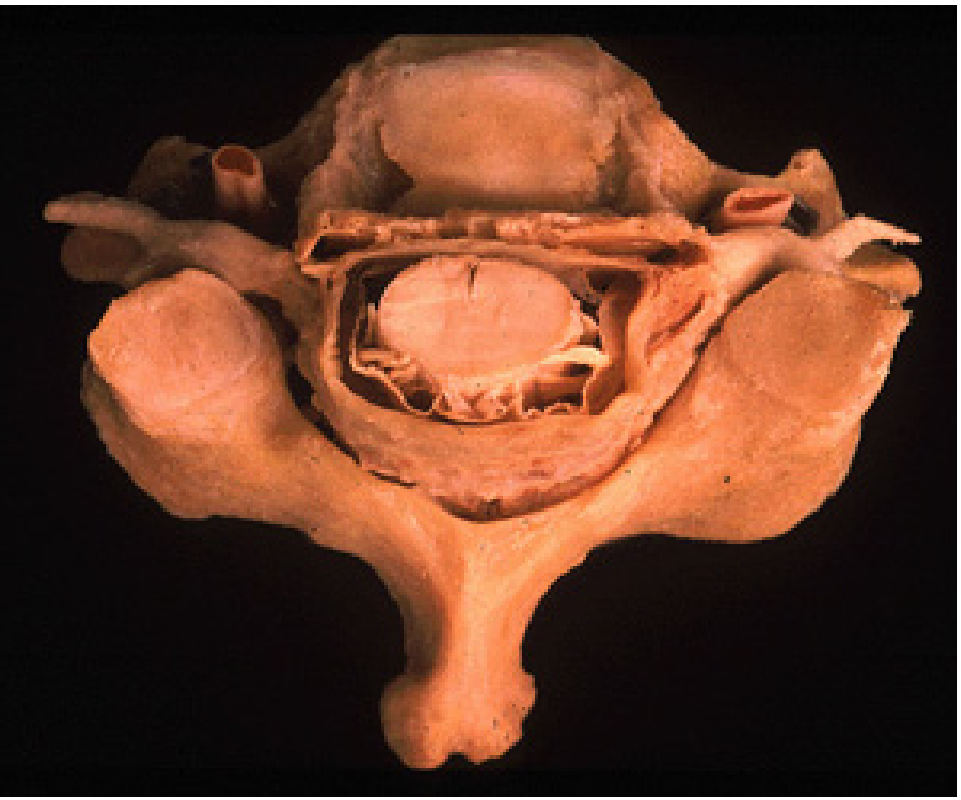


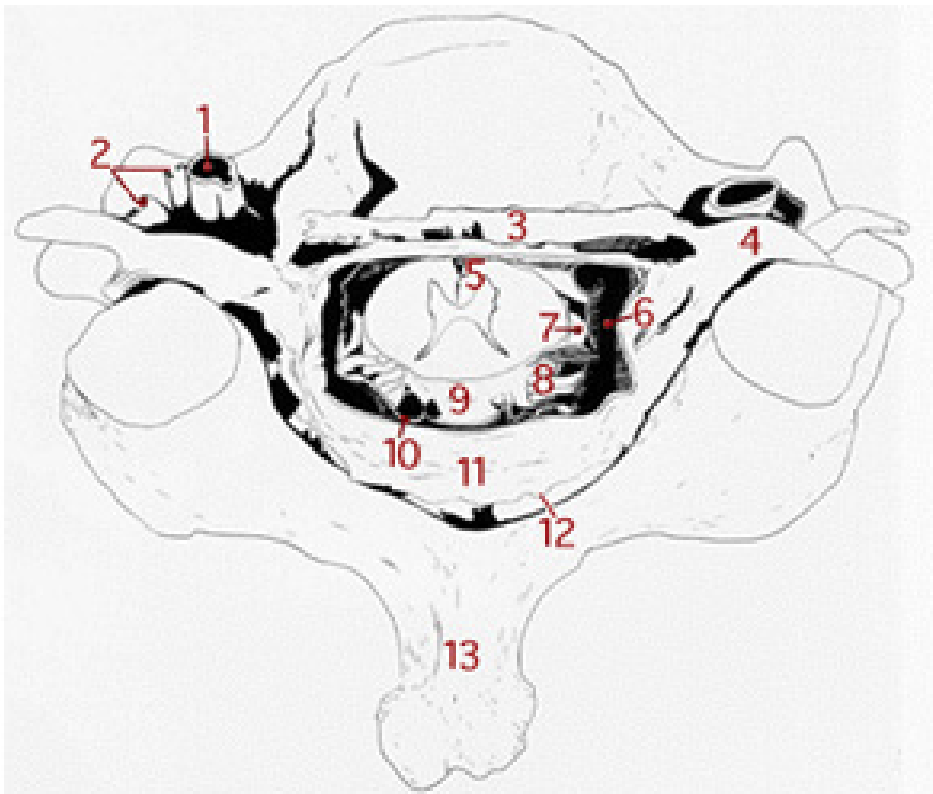
Cauda Equina

Meninges of the Spinal Cord

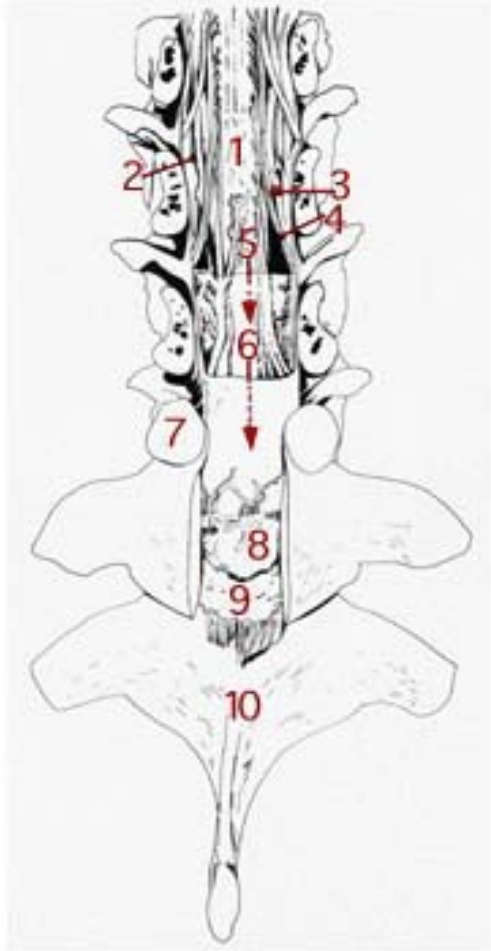
- three fibrous membranes that encloses the cord
  - **dura mater-** tough outer covering
    - **epidural space-** betwe vetebrae and dura mat contains blood vessels and adipose tissue
    - subdural space- space between dura and arachnoid mater
  - **arachnoid mater**
    - **subarchnoidl space-** contains CSF
  - **pia mater-** translucent membrane that close contours the cord and forms the **terminal filum** beyond the medullary cone







1. Vertebral artery **2.** Vertebral veins **3.** Posterior longitudinal ligament **4.** 3rd cervical spinal ganglion **5.** Ventral (anterior) median fissure with anterior spinal artery **6.** Subdural space **7.** Denticulate ligament **8.** Dorsal rootlets of 3rd cervical nerve **9.** Arachnoid trabeculae **10.** Arachnoid mater **11.** Dura mater **12.** Epidural fat **13.** Spinous process of 3rd cervical vertebra

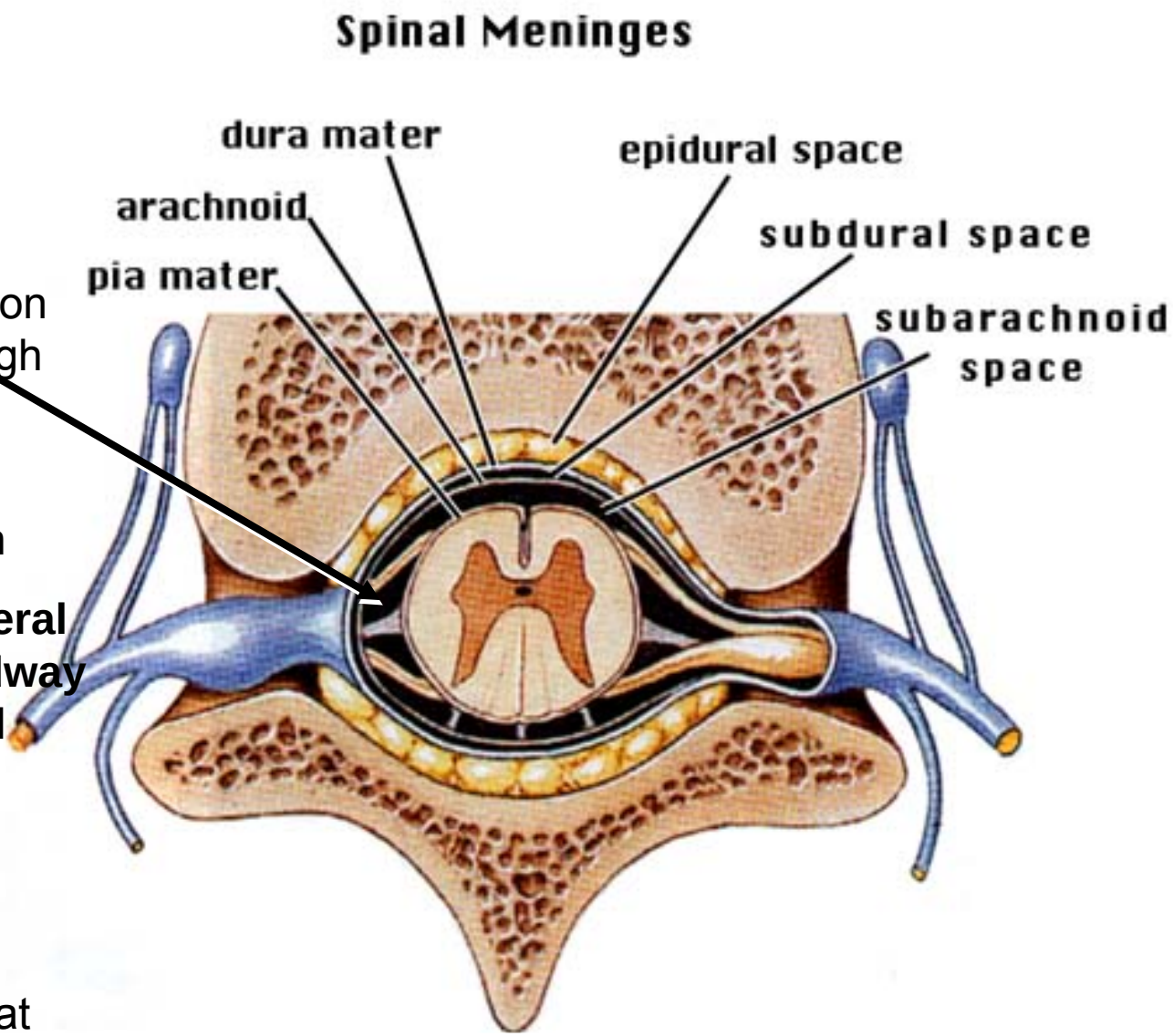


1. Pia mater
2. Denticulate ligament
3. Motor root of 7th thoracic nerve
4. Sensory root of 7th thoracic nerve
5. Subarachnoid space
6. Subdural space
7. Superior articular process of 9th thoracic vertebra

8. Epidural fat with internal vertebral venous plexus **9.** Ligamentum flavum **10.** 10th thoracic vertebra

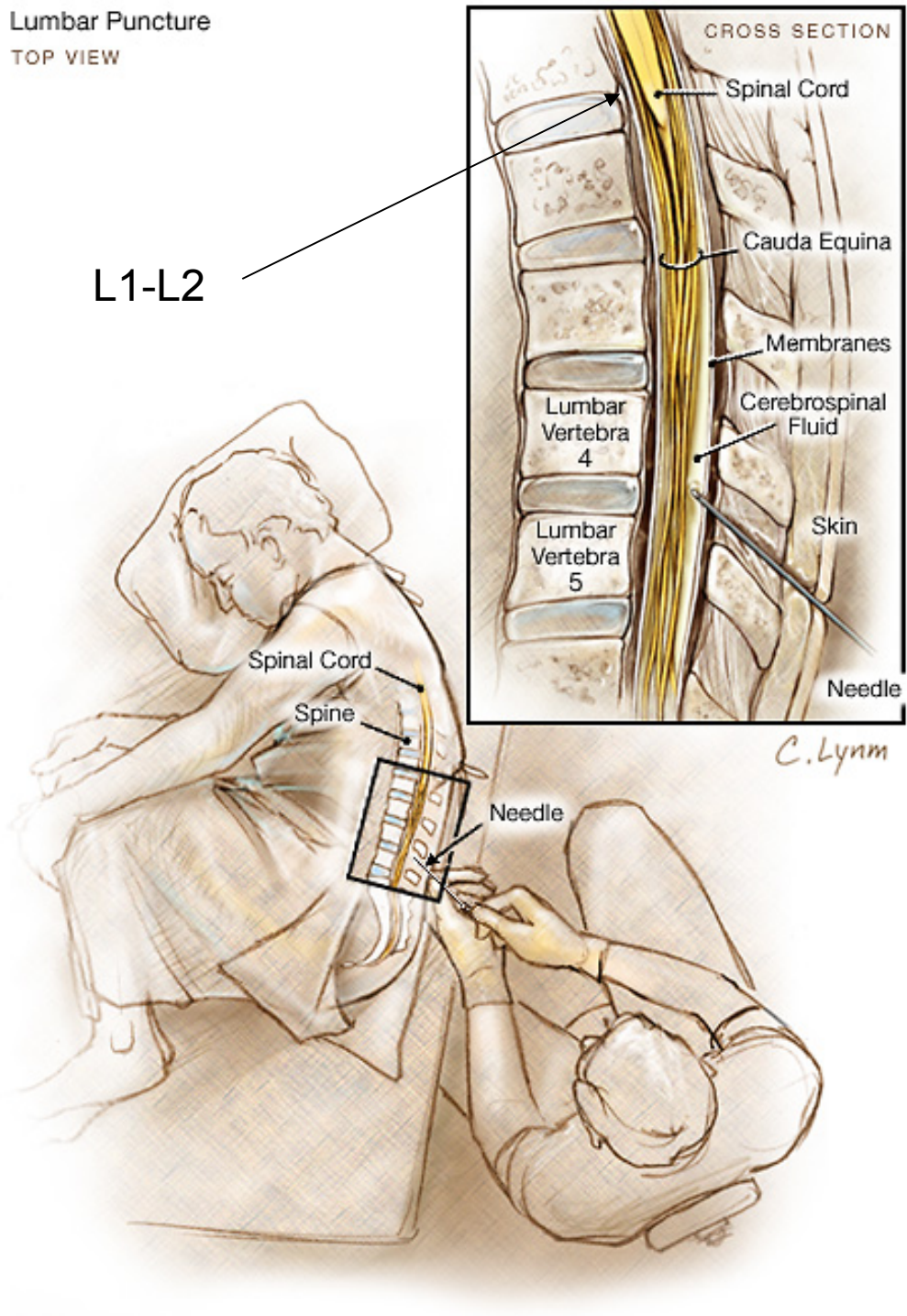
Dinticulate ligament- extension of the pia that extends through the arachnoid to the dura

- **suspends the spinal cord** in the dural sheath
- attached along the **lateral surface** of the cord **midway** between the **dorsal** and **ventral roots**.
- attached to the **dural sheath** at intervals **between** the **foramen magnum** and the level at which the dura mater is pierced by the **roots** of the **first lumbar spinal nerve**.



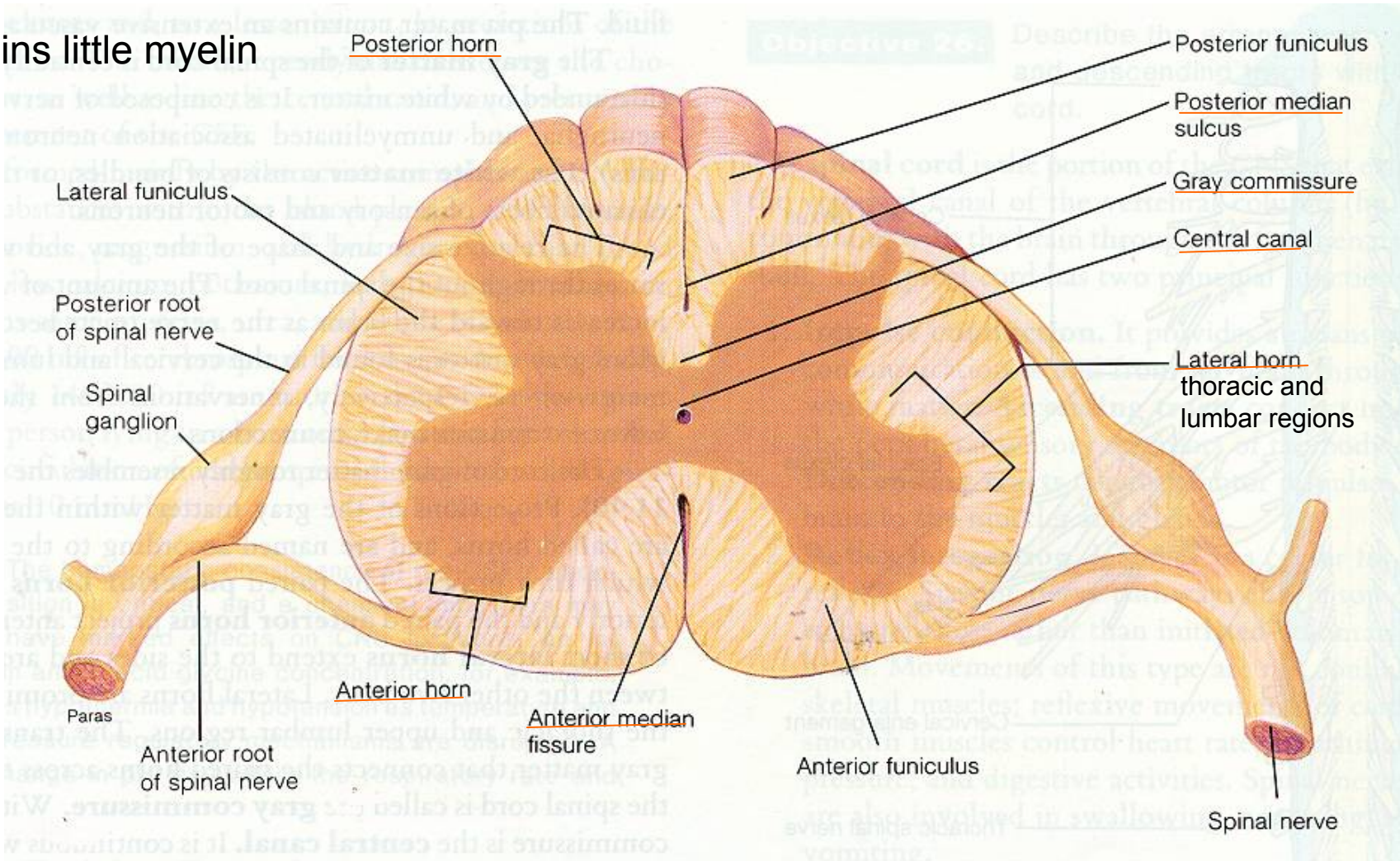
Lumbar Puncture

- The needle is inserted **between** the **arches of L3 and L4**.
- This **avoids any damage** to the **spinal cord**.

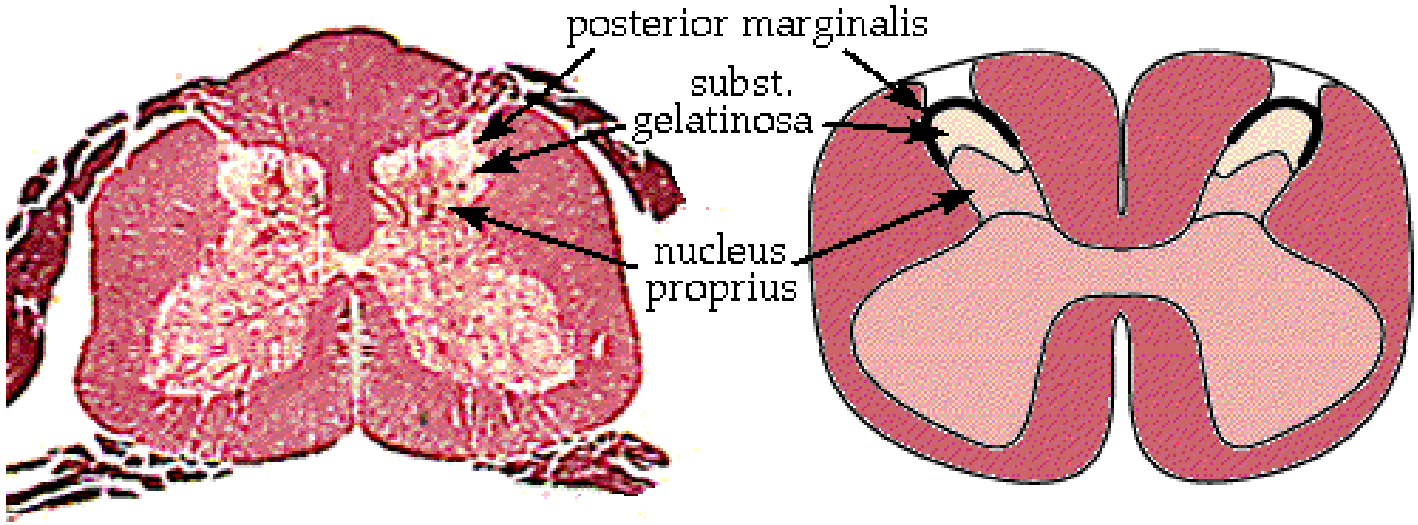


Cross-Section: Gray Matter

- contains cell bodies, dentrites, and proximal parts of neurons
- contains little myelin



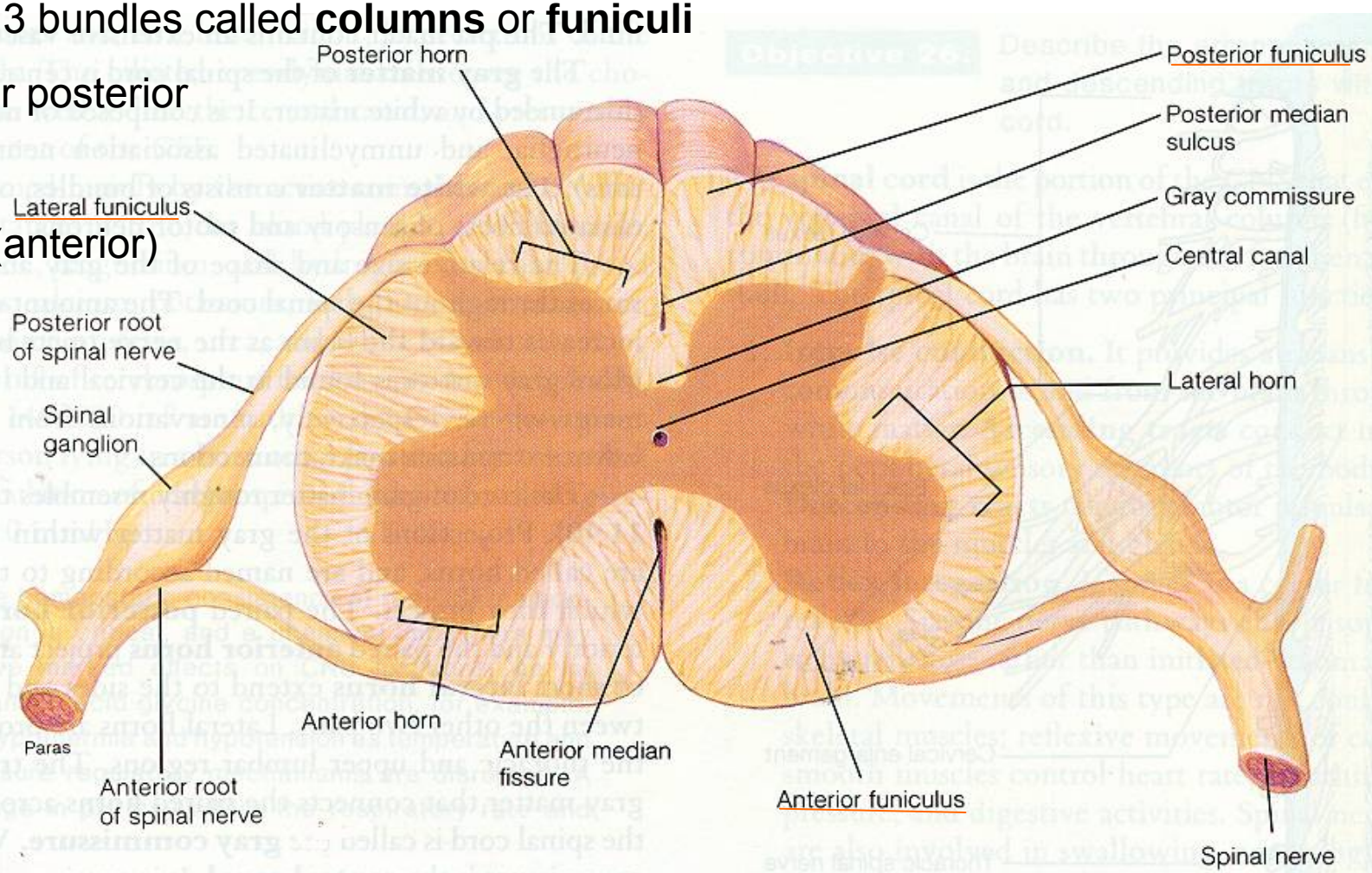
Cross-Section: Gray Matter



- The dorsal horn is a multi-layered structure.
  - The thin outermost layer is called the **posterior marginalis** layer.
  - The wide pale second layer is called the **substantia gelatinosa**,
  - and the layer deep to that is called the **nucleus proprius**.

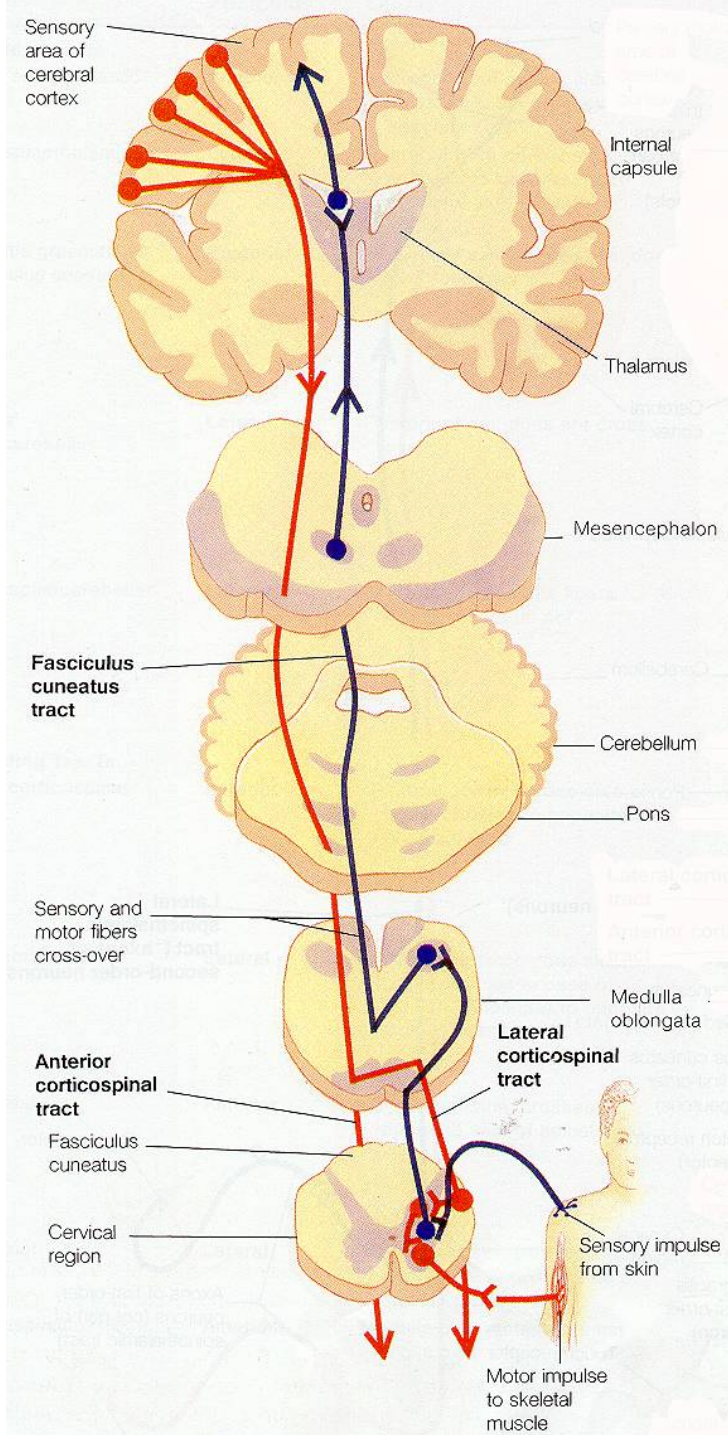
Cross-Section: White Matter

- consist of bundles of axons that course up and down the cord
- arranged in 3 bundles called **columns** or **funiculi**
  - dorsal or posterior
  - lateral
  - ventral (anterior)



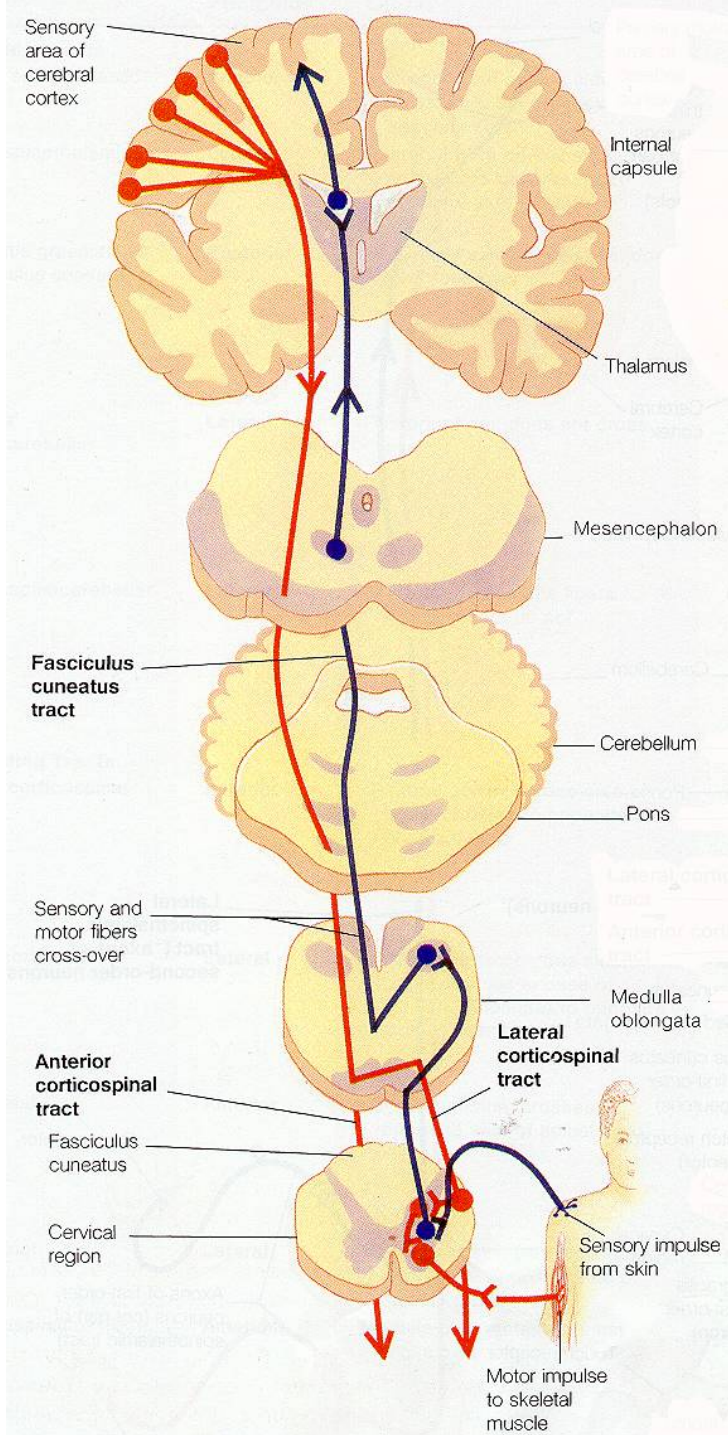
Spinal Tracts

- Columns consist of subdivisions called **tracts** or **fasciculi**
  - **ascending tracts- carry sensory info up the cord**
  - **descending tracts- conduct motor impulses down the cord**
- **Decussation- crossover**
  - **contralateral- when origin and destination are on opposite sides of the body**
  - **ipsilateral- on same side**



Ascending Tracts

- Sensory signals typically travel across three neurons from origin to destination
  - first order neuron- detects stimulus and transmits to cord
  - second order neuron- relays form cord to thalamus in brain stem
  - third order neuron- relays to sensory region of the cerebral cortex



Somatosensory System- multiple types of sensory input from the body

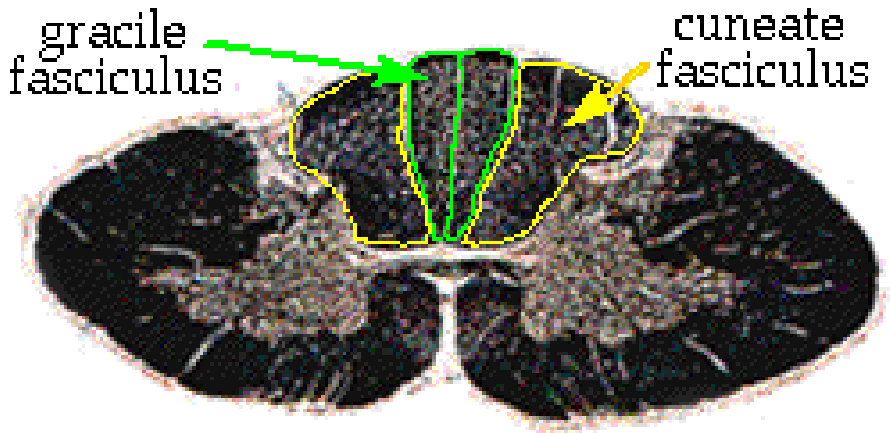
- Divided into three different pathways in the cord
  - **discriminative touch-** which includes touch, pressure, and vibration perception, and enables us to "read" raised letters with our fingertips, or describe the shape and texture of an object without seeing it.
  - **pain and temperature-** which is just what it sounds like, and also includes the sensations of itch and tickle.
  - **proprioception-** includes receptors for what happens below the body surface: muscle stretch, joint position, tendon tension, etc.

Somatosensory System- multiple types of sensory input from the body

- These modalities differ in their receptors, pathways, and targets, and also in the level of crossing.
  - The discriminative touch system crosses high - in the medulla.
  - The pain system crosses low - in the spinal cord.
  - The proprioceptive system is going to the cerebellum, which works ipsilaterally (same side). Therefore this system doesn't cross.

Ascending Tracts: Dorsal Column

- carries signals from the mid thorax and lower parts of body
- Above T6
  - composed of **gracile** (means slender) **and cuneate** (means wedge-shaped) **faciculus** (means a collection of axons)
  - below T6 is gracile only
- Fibers carry signal for
  - vibration sense
  - visceral pain
  - deep and discriminative touch (touch whose locations one can precisely identify
  - **propreoception** from the limbs and lower trunk

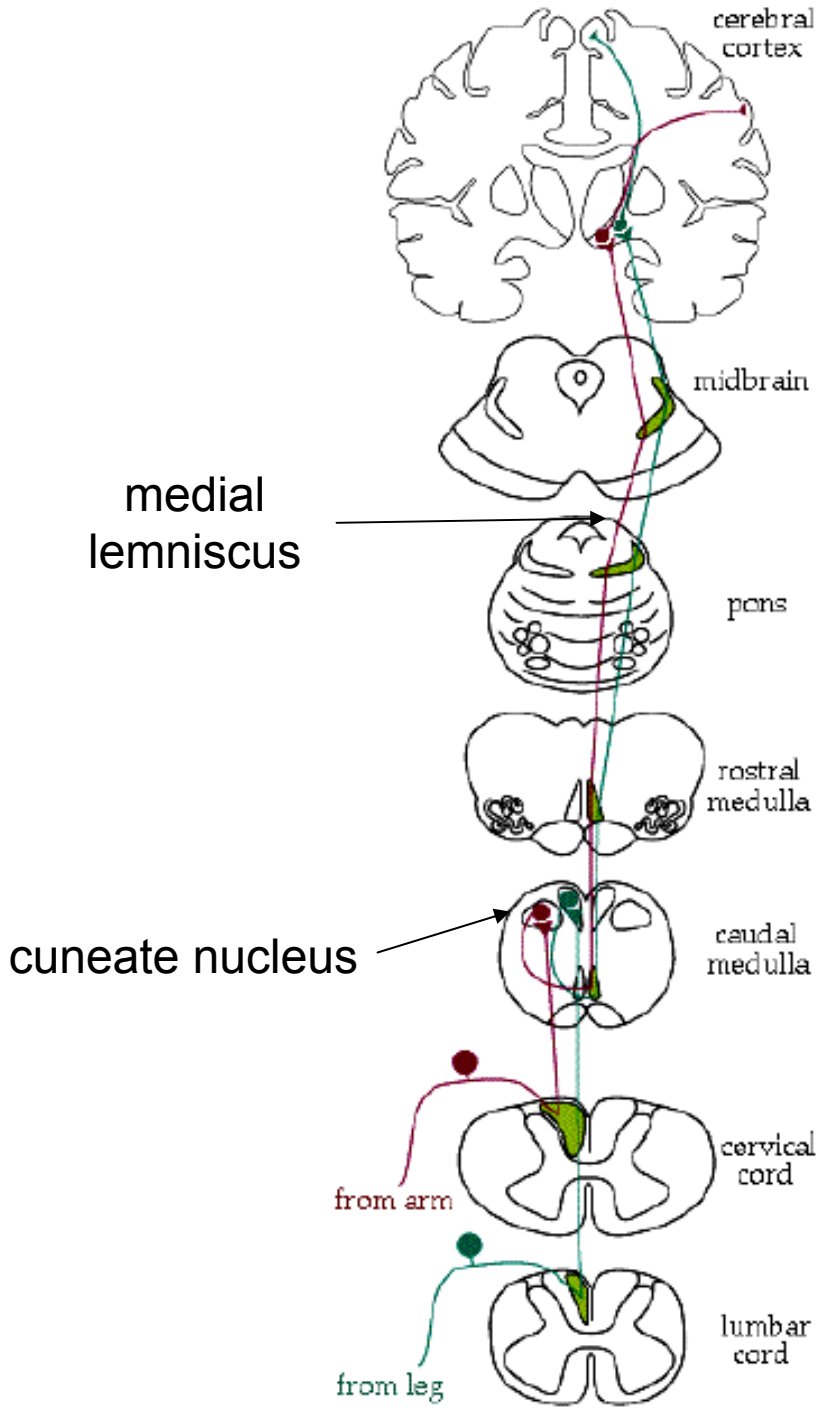


cuneate- carries info upper body (arms and turnk

gracile-carries info from lower body (legs and trunk)

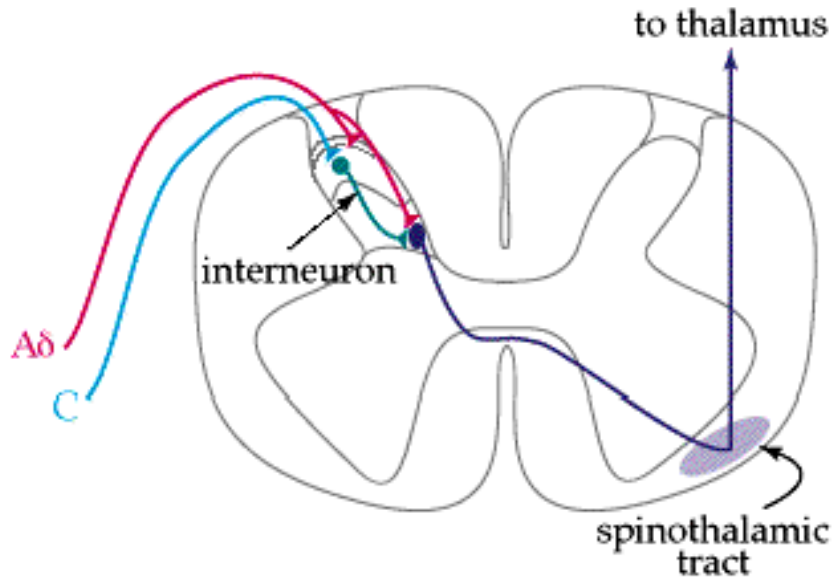
Dorsal Column

- first order- sensory receptor to **cuneate nucleus** and **gracile nucleus** in medulla, ipsilateral side
- second order- descussate and form the **medial lemniscus** (midline ribbon), tract that leads to thalamus
- third order- from thalamus to contralateral sensory cortex



Anterolateral System

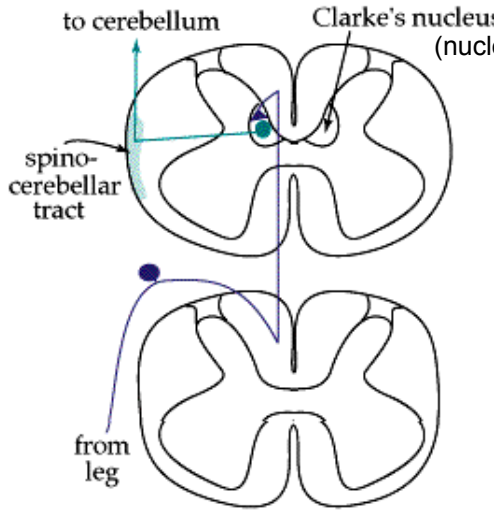
- **Spinothalamic tract-** pass up the anterior lateral columns of the cord
- carries signals for pain, temperature, pressure, tickle, itch, and light or crude touch
- first order neurons enter dorsal horn, synapse and desussate to form the ascending spinothalamic tract from second order neurons

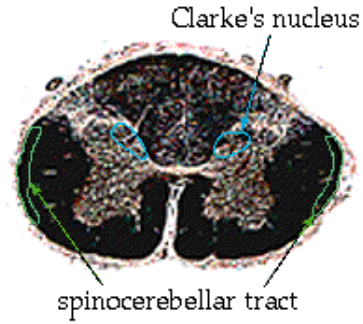


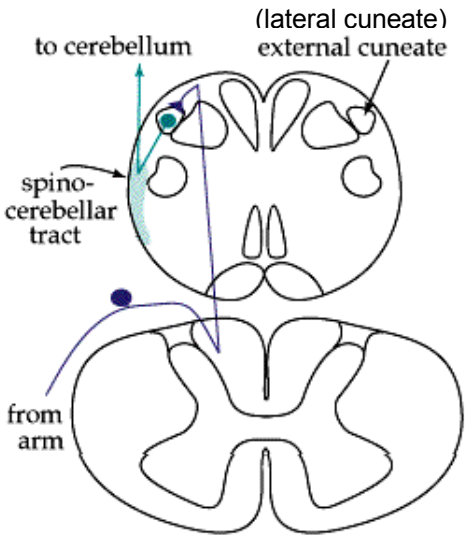
Anterolateral System

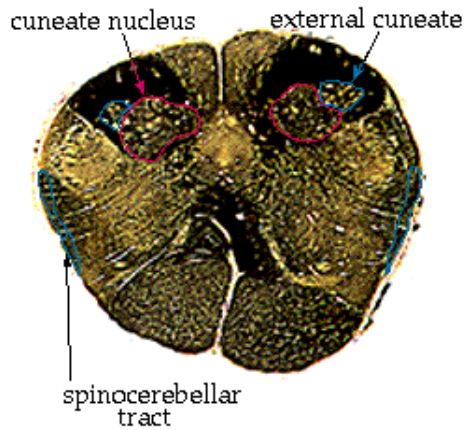
Dorsal spinocerebellar tracts

- proprioceptive system of the afferents from muscle spindles, Golgi tendon organs, and joint receptors.
- joins the discriminative touch system, in the posterior columns, for a few segments.
- slips out of the dorsal white matter, synapses and second order fibers <u>ascends without crossing</u> to the cerebellum (a large motor control area at the rear of the brain)









Anterolateral System

Ventral spinocerebellar tract

- travels in approximately the same place - the lateral margin of the spinal cord, just ventral to the dorsal spinocerebellar tract.
- The two cannot be distinguished in a normal myelin stain.
- fibers entering it in the spinal cord actually cross on their way into the tract. However, they (somewhat inefficiently) cross back before entering the cerebellum.
- Therefore the cerebellum still gets information from the ipsilateral body.

Descending Tracts

- **carry motor signals** down form the brainstem and spinal cord
- typically involves two neurons called **upper and lower motor neuron**
  - upper **begins a soma in cerebral cortex** or brainstem with an axon that **terminates on the lower neuron**
  - lower motor neurons are large neurons (α-motor neurons) **in the ventral horns** of the spinal cord that send their axons out via the spinal roots and **directly control the muscles.**

Descending Tracts

- Divided into
  - **pyramidal tracts**
    - **corticospinal tract**
    - **corticobulbar tract-** axons which innervate the muscles of the face
  - **extrapyramidal tracts- all other motor components**
    - relays output from cortex to midbrain structures
    - exerts its effect on voluntary movement primarily by influencing the activity of the pyramidal system
      - ex: dampens erratic motions, maintains muscle tone and truncal stability.

Pyramidal tract: Corticospinal Tract

- carry signals for **precise finely coordinated limb movements**
- fibers **form ridges called pyramids on the ventral surface of medulla** (hence, pyramidal tract)
- most of the **fibers decussate in the lower medulla** and form the **lateral corticospinal tract**
- a **few fibers remain uncrossed** and form the **ventral corticospinal tract** on the ipsilateral side

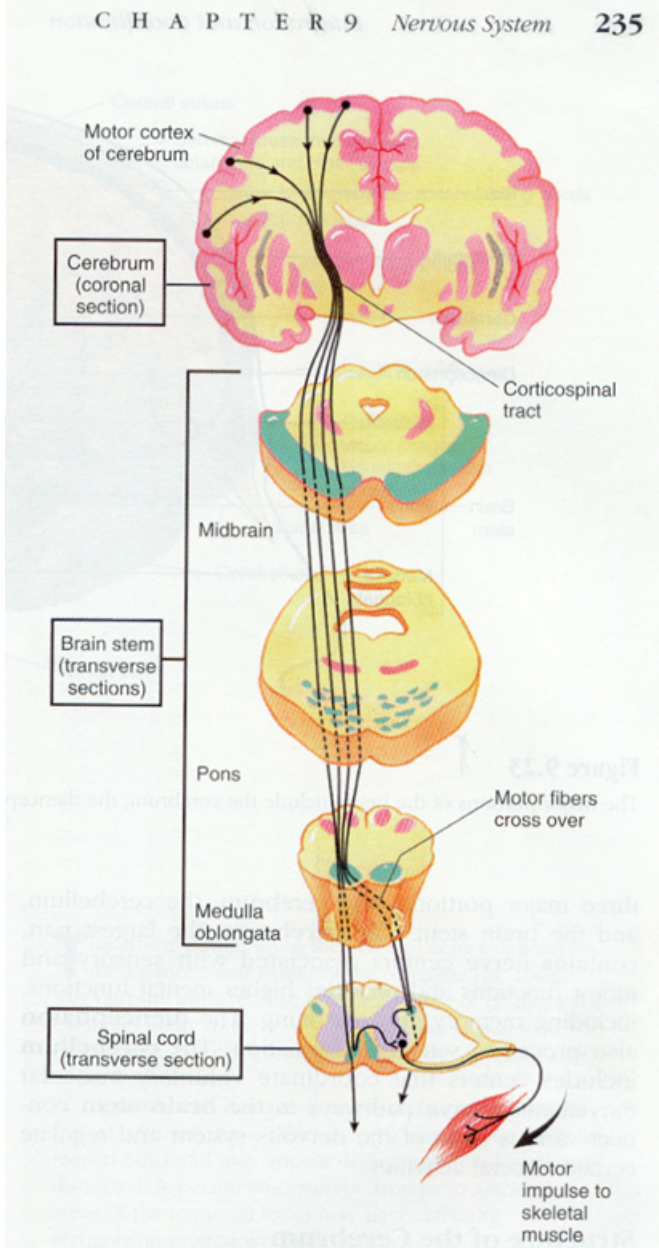
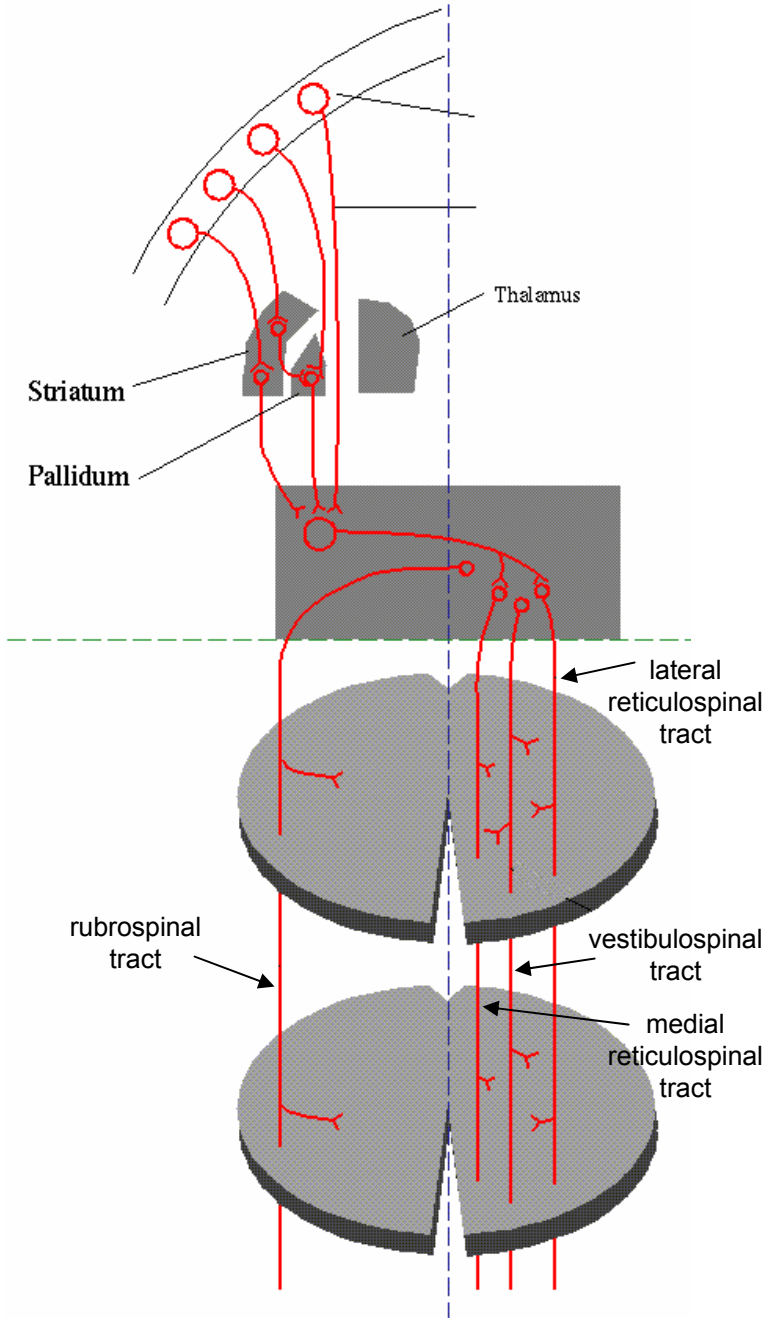


Figure 9.22

Motor fibers of the corticospinal tract begin in the cerebral cortex, cross over in the medulla oblongata, and descend in the spinal cord. There, they synapse with neurons whose fibers lead to the spinal nerves that supply skeletal muscles.

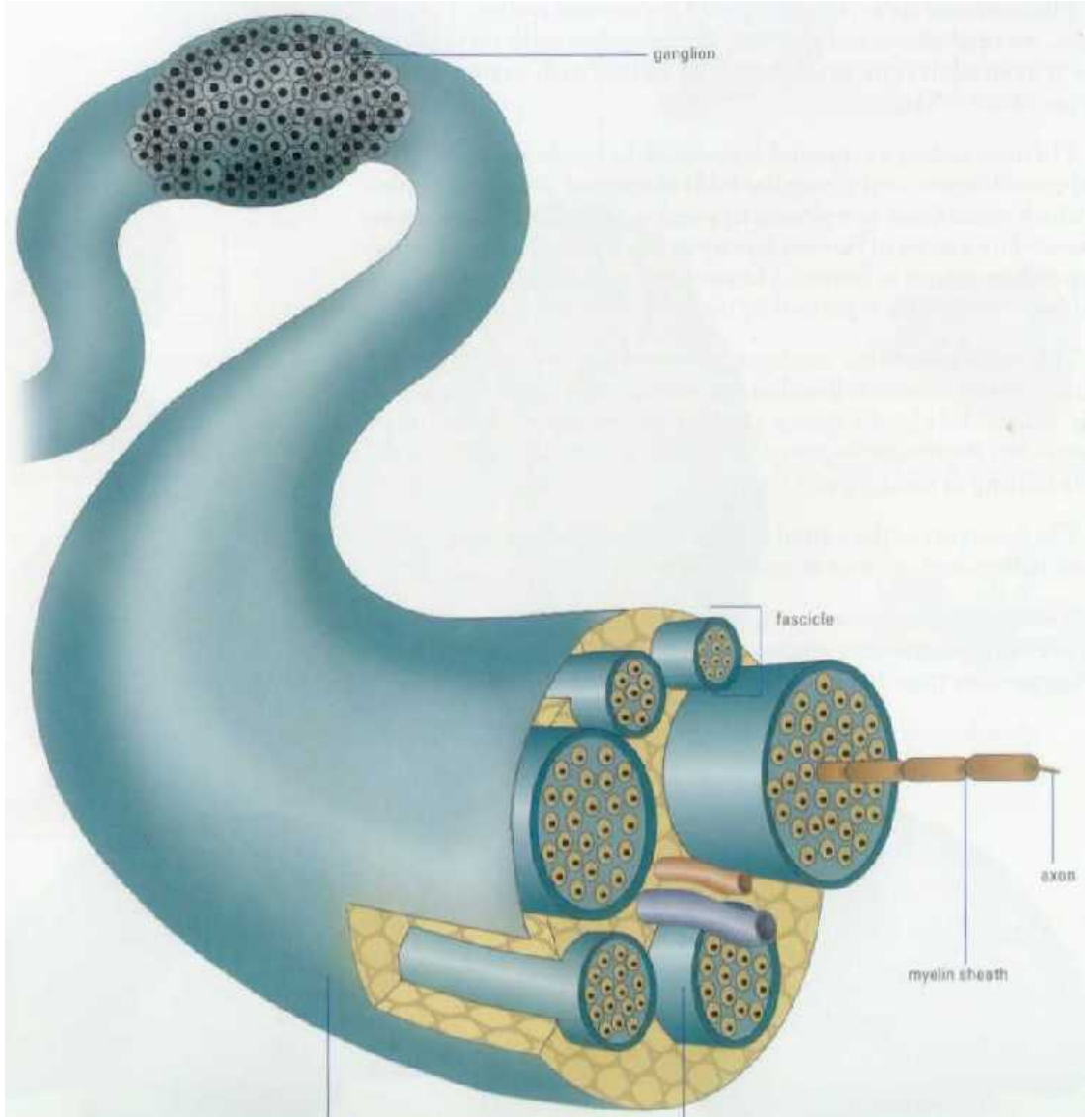
Extrapyramidal Tract

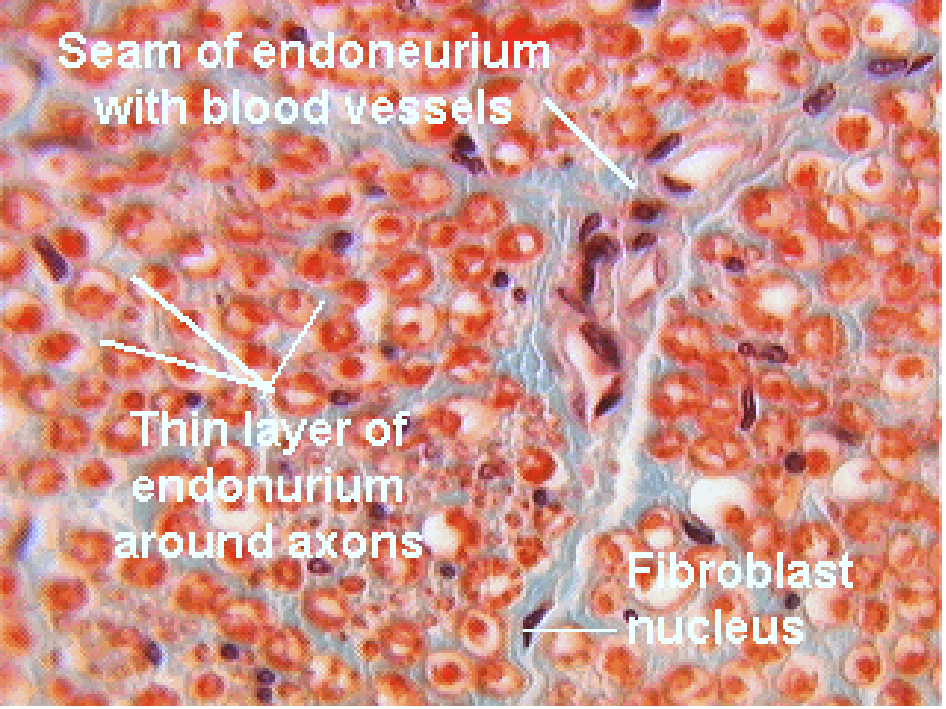
- **Lateral & medial tectospinal tracts**
  - are found in cervical cord segments only.
  - involved in reflex movement of the head, especially in response to visual and auditory stimuli
- **Lateral & medial reticulospinal tract**
  - control muscles of the upper and lower limbs, especially to maintain posture and balance
  - contain descending analgesic pathways that reduce pain transmission to brain
- **Vestibulospinal tract**
  - begins at brainstem carrying impulses from inner ear
  - tract passes down ventral column
  - controls limb muscles that maintain balance and posture
- **Rubrospinal tract**
  - aid in muscle coordination
  - almost nonexistent in humans and have little functional importance

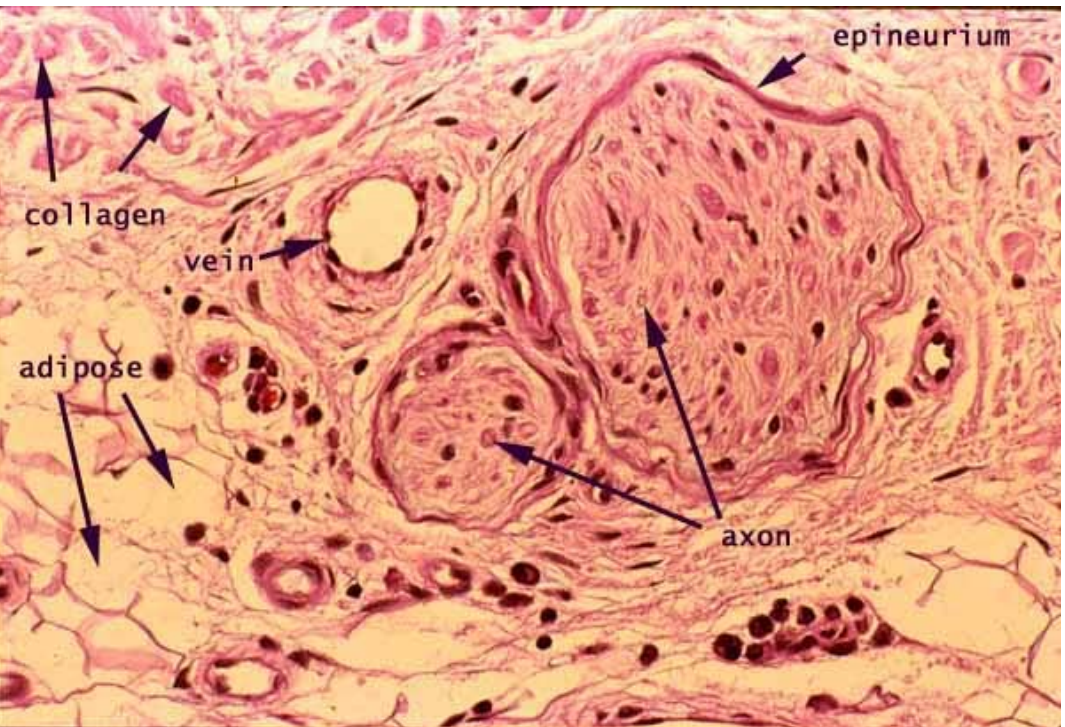


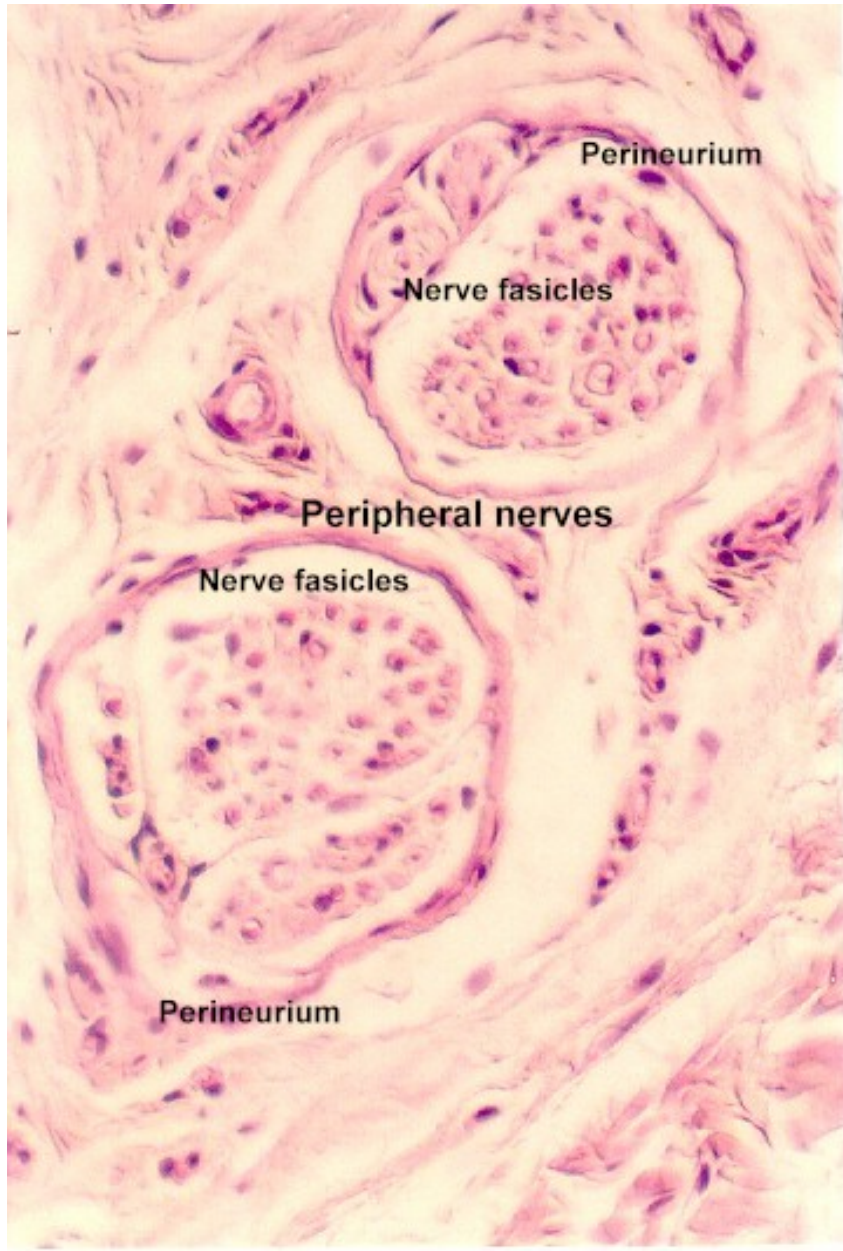
General Anatomy of Nerves

- nerve- consist of bundles neuronal axons (nerve fiber)
  - **endoneurium**- c.t. surrounding each nerve fiber
  - **perineurium**- encases nerve bundles called **fascicles**, blood vessel penetrate to this level
  - **eipineurium**- composes the nerve as a whole
    - dense irregular c.t. that protects the nerve from stretching and injury




Seam of endoneurium with blood vessels
Thin layer of endonurium around axons
Fibroblast nucleus


epineurium
collagen
vein
adipose
axon

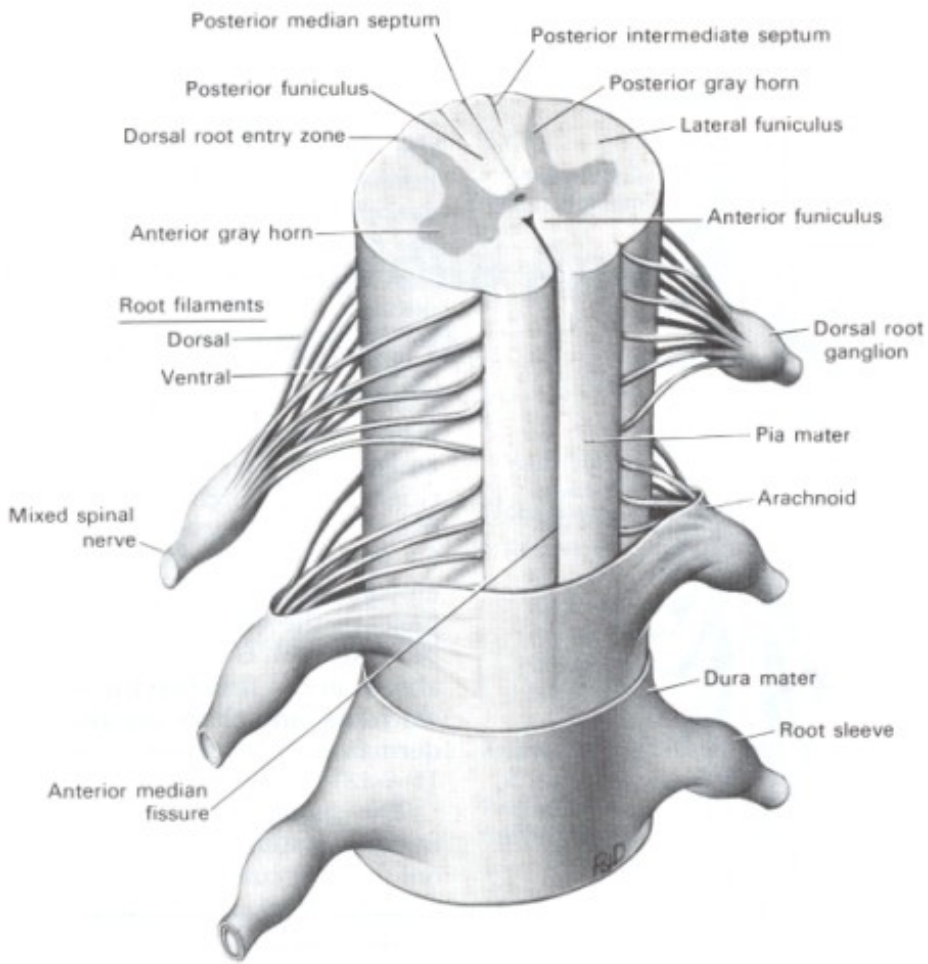

Perineurium
Nerve fasicles
Peripheral nerves
Nerve fasicles
Perineurium

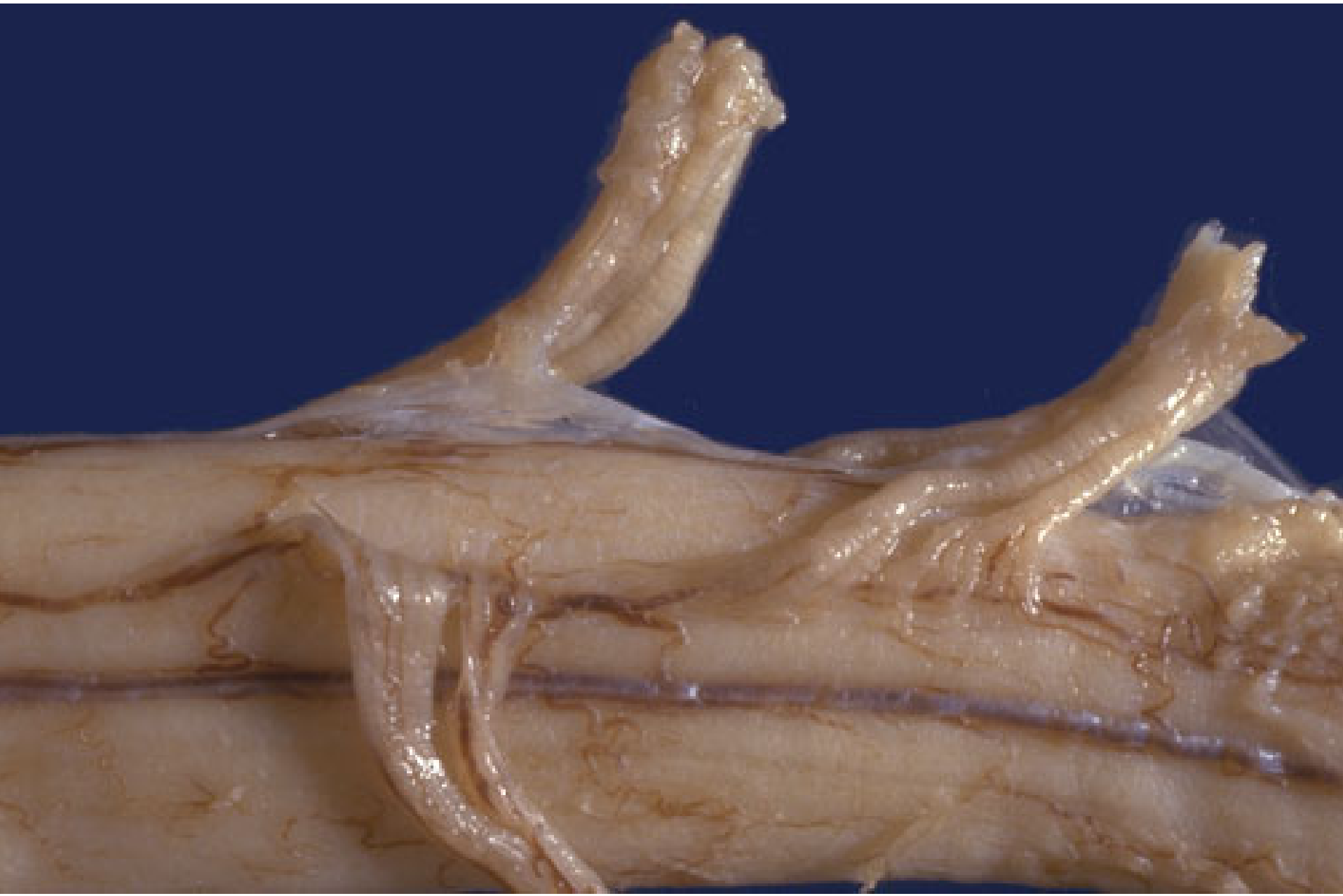
Peripheral Nerves

- **sensory or afferent-** carry signals from sensory receptors to the CNS
    - olfactory and optic
- **motor or efferent-** carry signals away form the CNS to muscles and glands
- **mixed nerve**- contains both sensory and motor
  - most fibers are mixed
- **ganglion**- cluster of cell bodies (somas) outside the CNS
  - incases in epineurium that is continuous with the nerve

Spinal Nerves

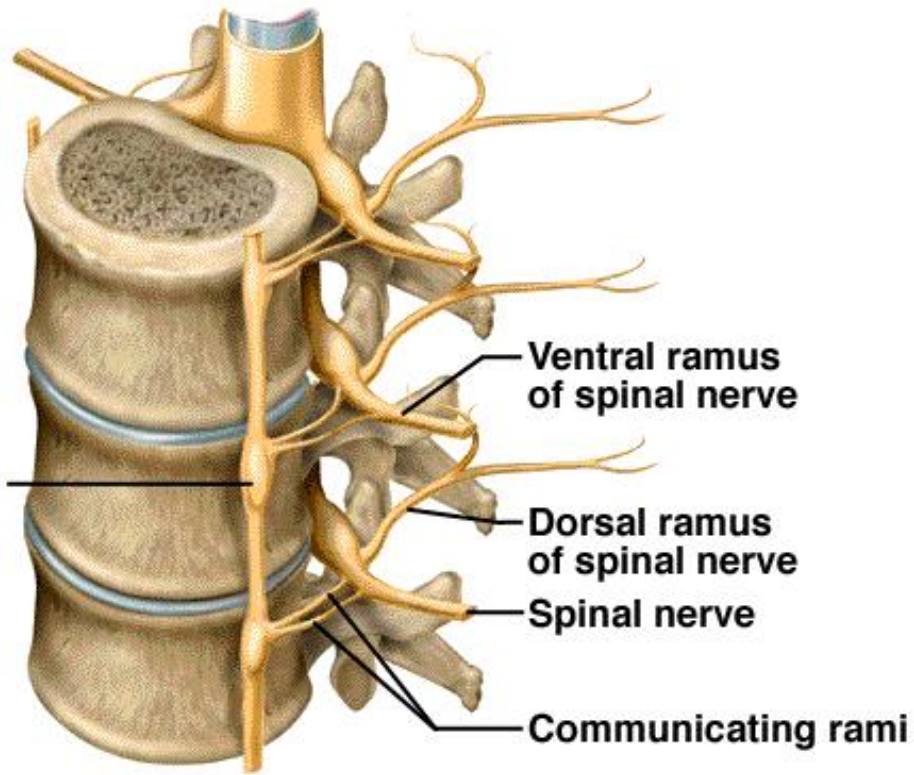
- 31 pairs of spinal nerves
- each spinal nerve has two points of attachment to the cord
  - dorsal root- divides into 6-8 rootlets that enter the cord
  - distal to the rootlet is the small swelling called the dorsal root ganglion which contain the somas of the sensory afferent neurons
  - Ventral root- composes of 6-8 rootlets that converge to it
    - are efferent (motor) fibers





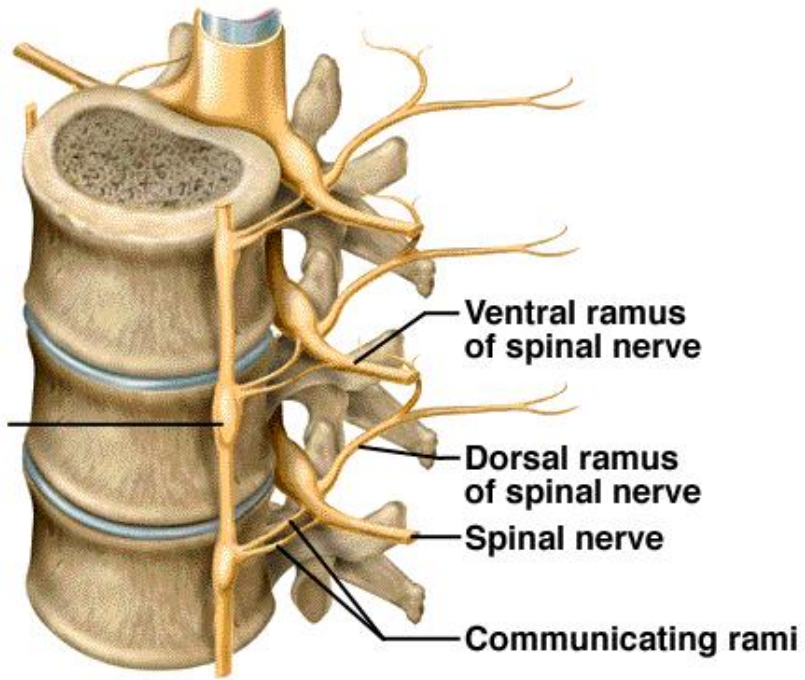
Spinal Nerve

- distal to the vertebrae, the spinal nerve branches into the **dorsal** and **ventral ramus** and a small **meningeal branch**



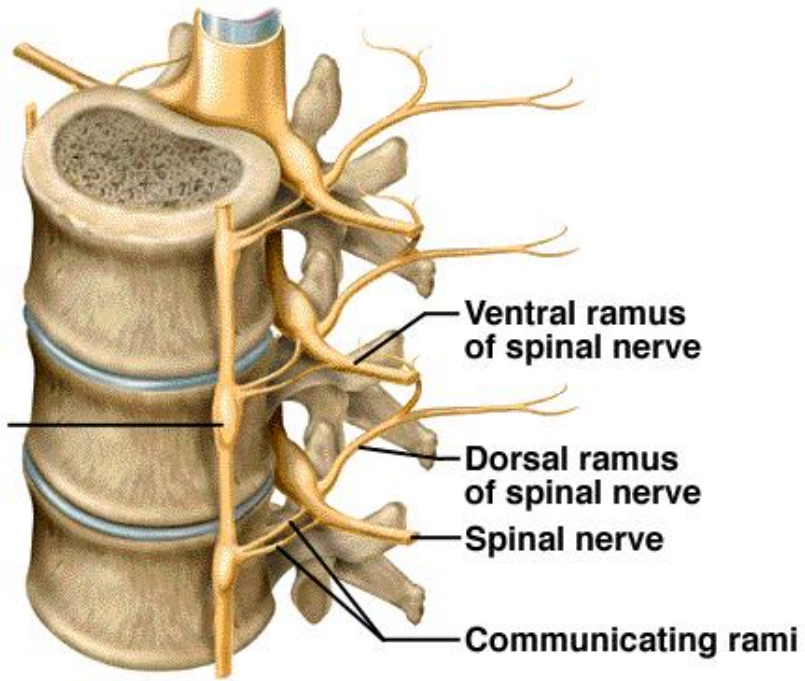
Spinal Nerves

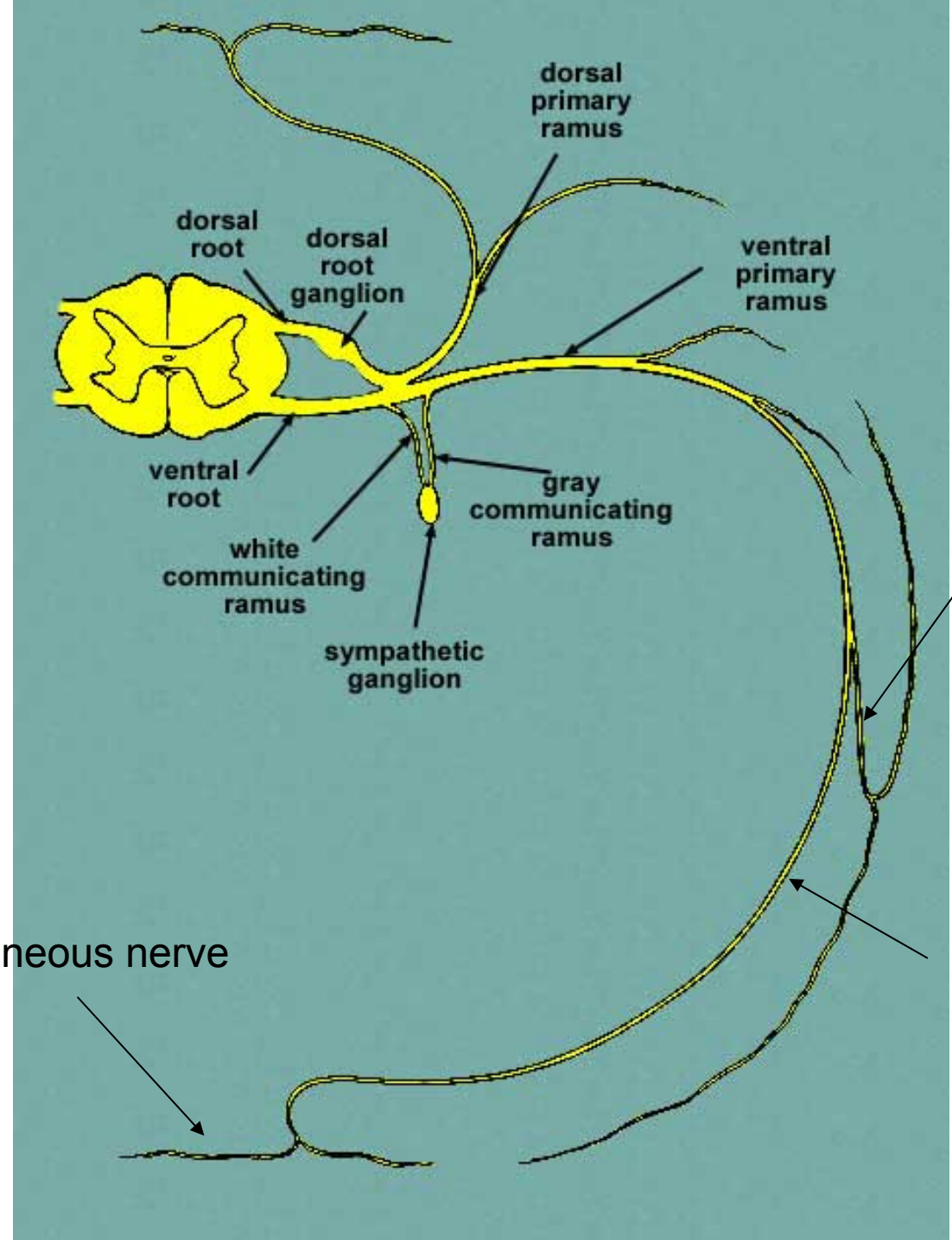
- **Meningeal branch- reenters the vertebral canal** and **innervates the meninges**, vertebrae, and spinal ligaments
- **Dorsal ramus- supplies motor and sensory innervation of the skin and muscles of the back. It does not contribute to limb innervation or plexus formation.**



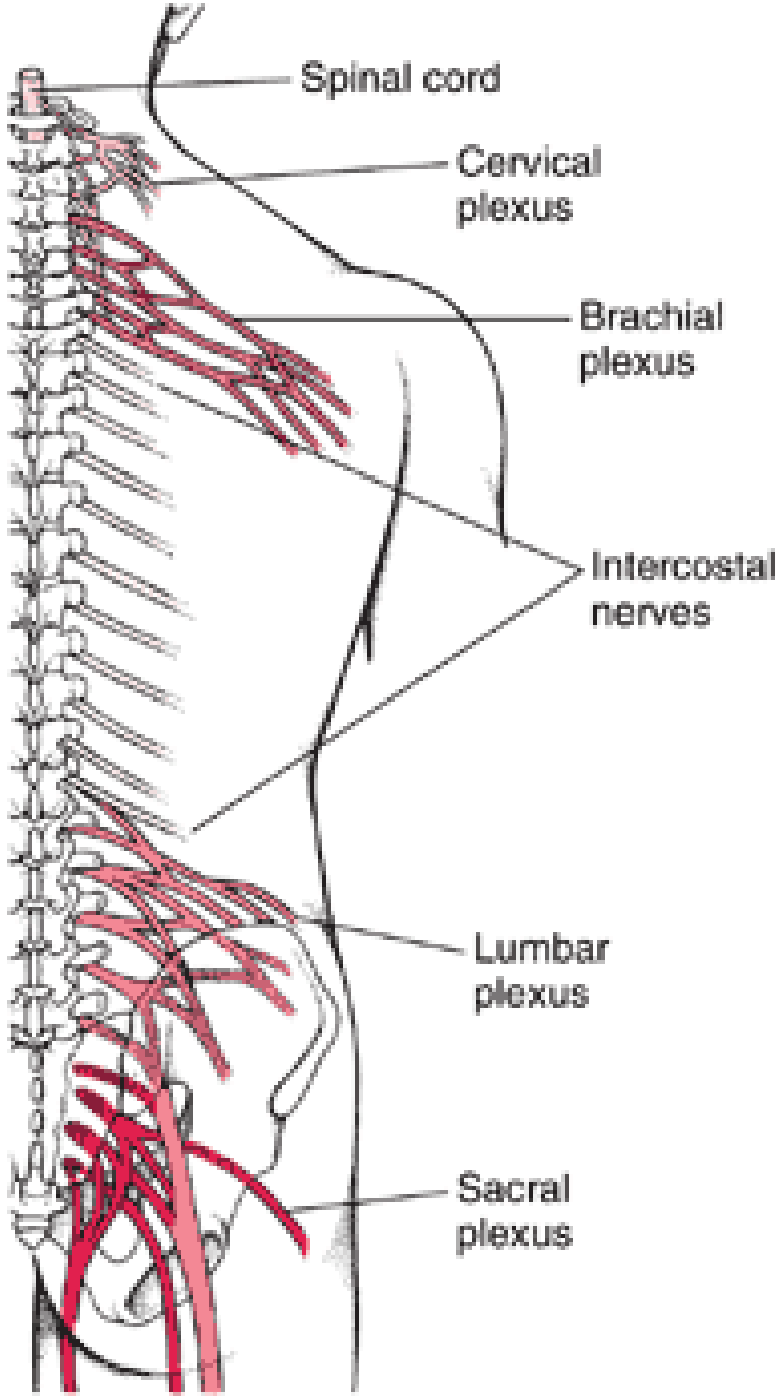
Spinal Nerves

- **Ventral ramus-** innervates the **ventral and lateral skin** and **muscles of the trunk** and gives rise to the nerves of the limbs
- ventral ramus differs from one region of the trunk to another
  - thoracic region- forms **intercostal nerves** to innervate the skin and intercostal muscles, internal oblique, external oblique, and transversus abdominis
  - **other ventral rami form the <u>nerve plexuses</u>**



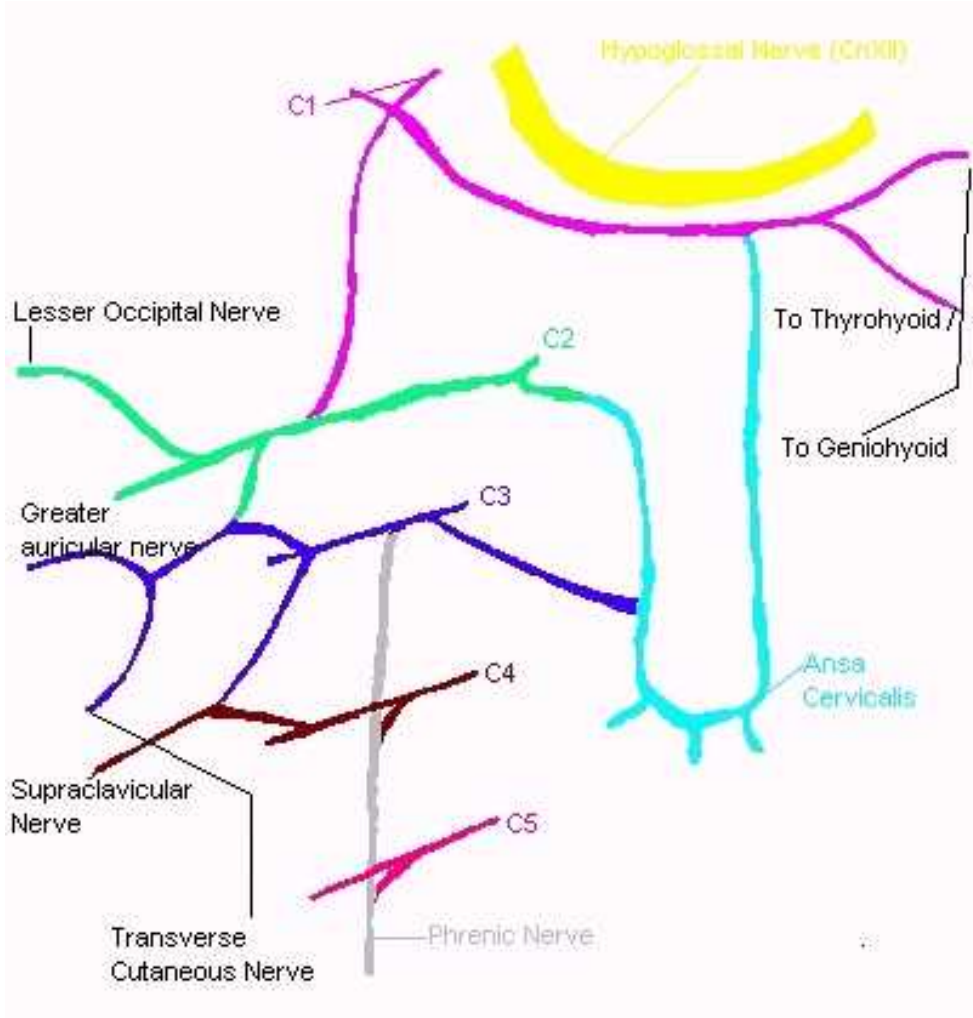

dorsal primary ramus
dorsal root
dorsal root ganglion
ventral primary ramus
lateral cutaneous nerve
ventral root
gray communicating ramus
white communicating ramus
sympathetic ganglion
anterior cutaneous nerve
intercostal nerve

- A **nerve plexus** is a network of interwoven nerves,
- Nerve fibers from different spinal nerves are sorted and recombined in plexuses, so that all fibers going to a specific body part are put together in one nerve.
- Four nerve plexuses are located in the trunk of the body.
  - **cervical plexus** provides nerve connections to the head, neck, and shoulder.
  - **brachial plexus** provides connections to the chest, shoulders, upper arms, forearms, and hands.
  - **lumbar plexus** provides connections to the back, abdomen, groin, thighs, knees, and calves.
  - **sacral plexus** provides connections to the pelvis, buttocks, genitals, thighs, calves, and feet. Because the lumbar and sacral plexuses are interconnected, they are sometimes referred to as the **lumbosacral plexus**.
- **The spinal nerves in the chest do not join a plexus; they are the intercostal nerves, which are located between the ribs.**



Cervical Plexus

- **formed from the anterior rami of the first four cervical nerves (C1-C4).**
- is located lying on **scalenus medius** and its anterior side is covered by **scalenus anterior**, the prevertebral fascia, and the internal jugular vein within the carotid sheath.



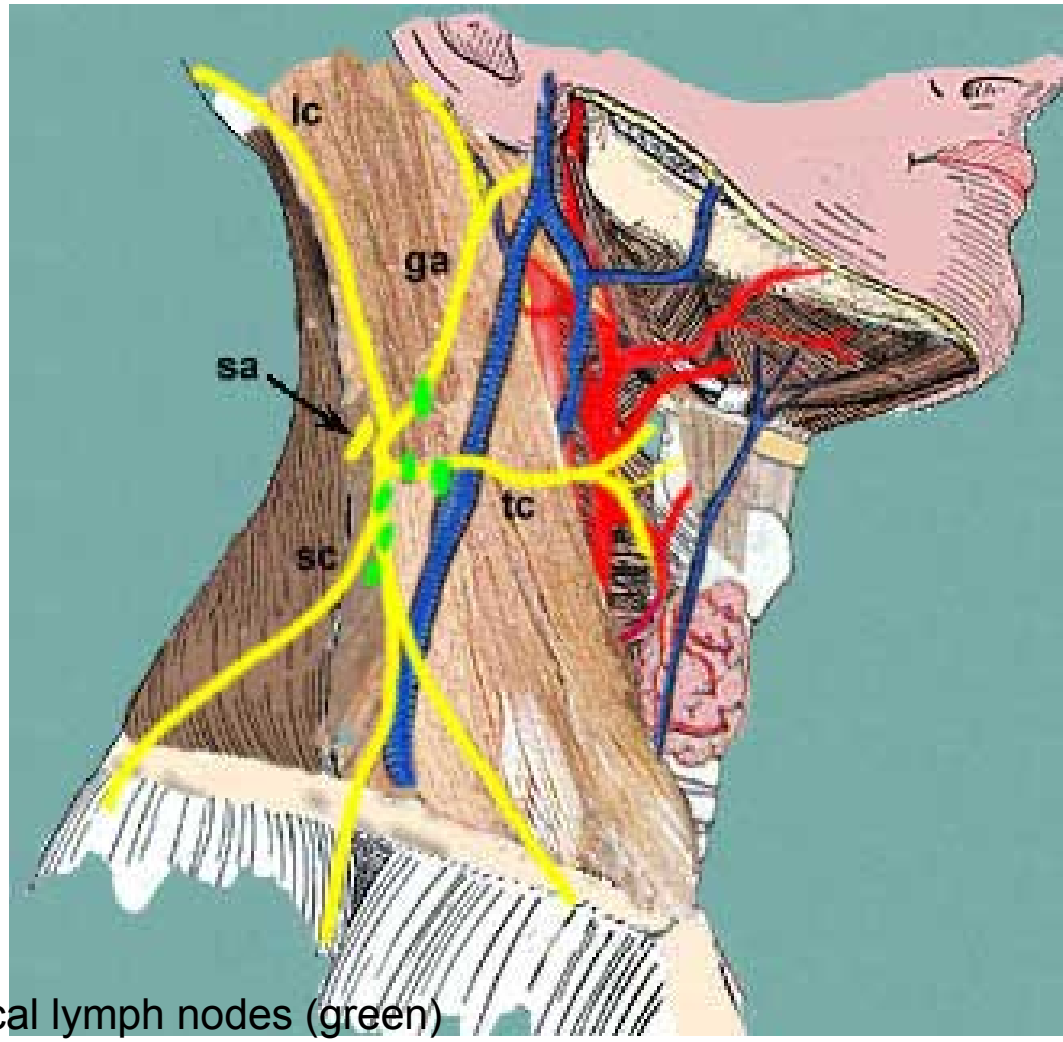
Cervical Plexus (cont)

Cutaneous innervation of head and shoulder area

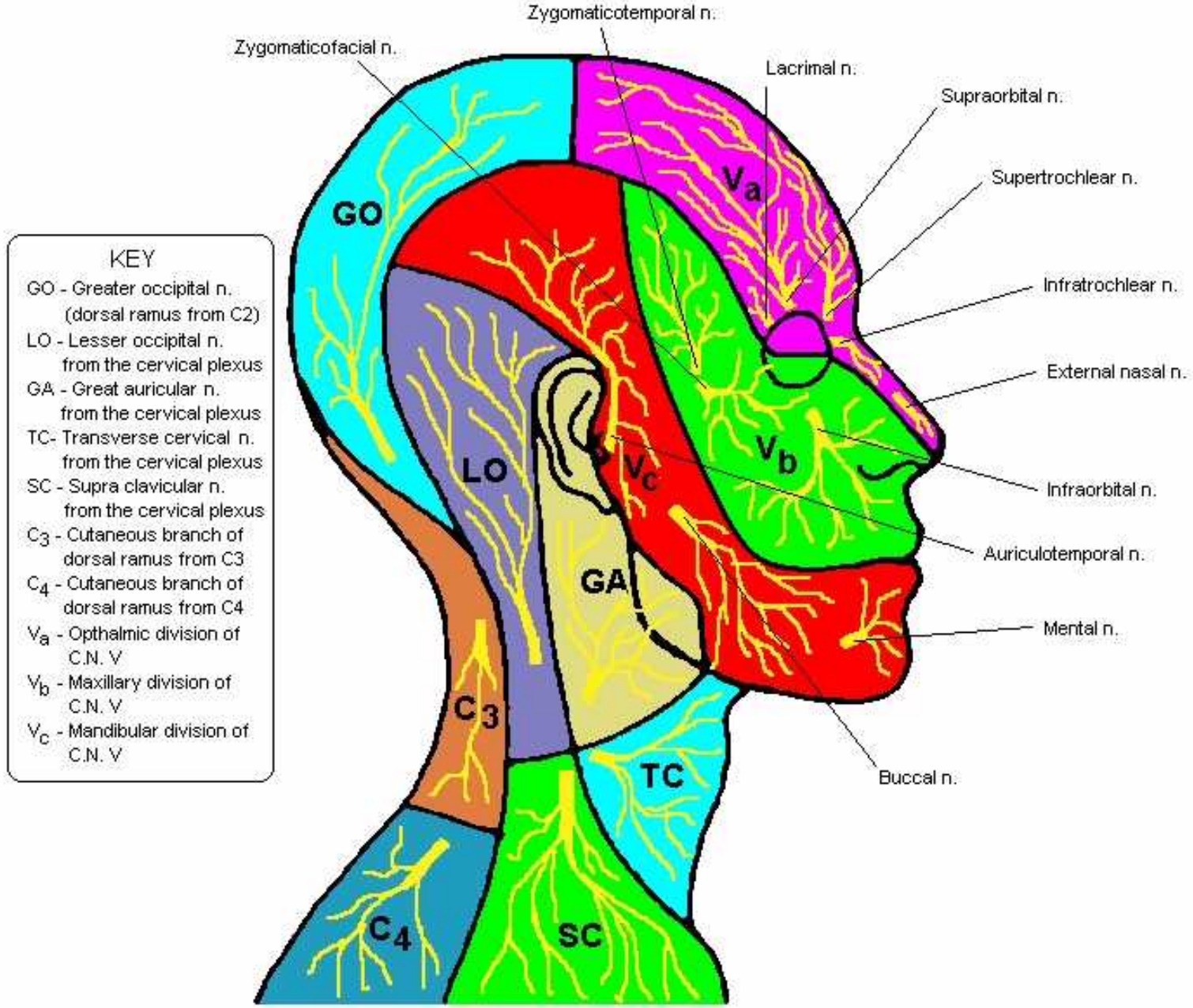
- **Lesser Occipital Nerve** (C2 & C3)
- **Greater Auricular Nerve** (C2 & C3)
- **Transverse Cutaneous Nerve** (C2 & C3)
- **Supraclavicular Nerves** (C3 & C4)

Muscular innervation

- sternocleidomastoid (C2 & C3)
- levator scapulae (C3 & C4)
- trapezius (C3 & C4).



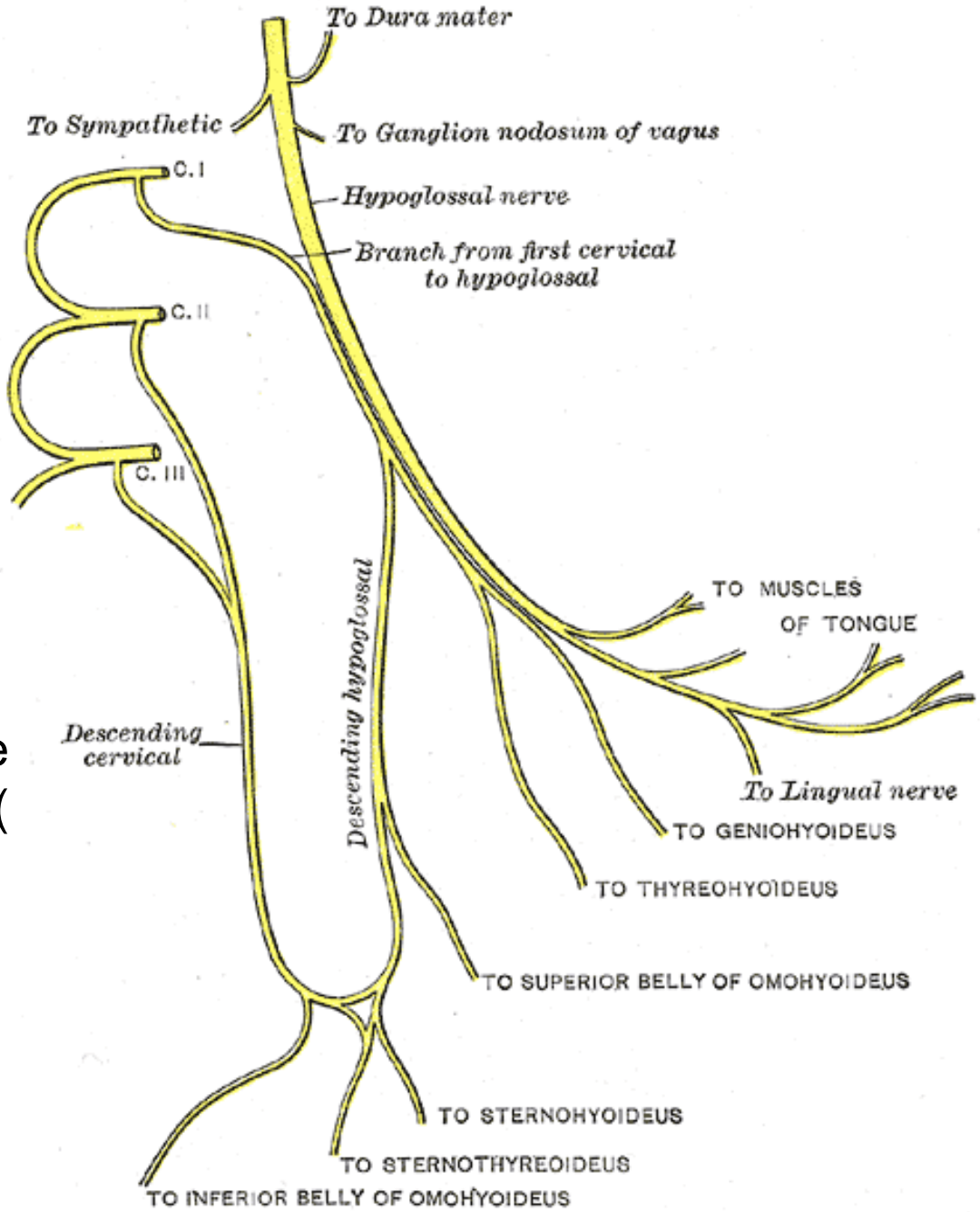
external jugular vein (blue) ,superficial cervical lymph nodes (green)
lesser occipital nerve (lc), great auricular nerve (ga), transverse cervical nerve (tc)
supraclavicular nerves (sc), spinal accessory nerve (sa)


KEY
GO - Greater occipital n. (dorsal ramus from C2)
LO - Lesser occipital n. from the cervical plexus
GA - Great auricular n. from the cervical plexus
TC- Transverse cervical n. from the cervical plexus
SC - Supra clavicular n. from the cervical plexus
C3 - Cutaneous branch of dorsal ramus from C3
C4 - Cutaneous branch of dorsal ramus from C4
Va - Opthalmic division of C.N. V
Vb - Maxillary division of C.N. V
Vc - Mandibular division of C.N. V
Zygomaticotemporal n.
Zygomaticofacial n.
Lacrimal n.
Supraorbital n.
Supertrochlear n.
Infratrochlear n.
External nasal n.
Infraorbital n.
Auriculotemporal n.
Mental n.
Buccal n.
GO
Va
LO
Vc
Vb
GA
C3
TC
C4
SC

Cervical Plexus (cont)

Muscular innervation (cont)

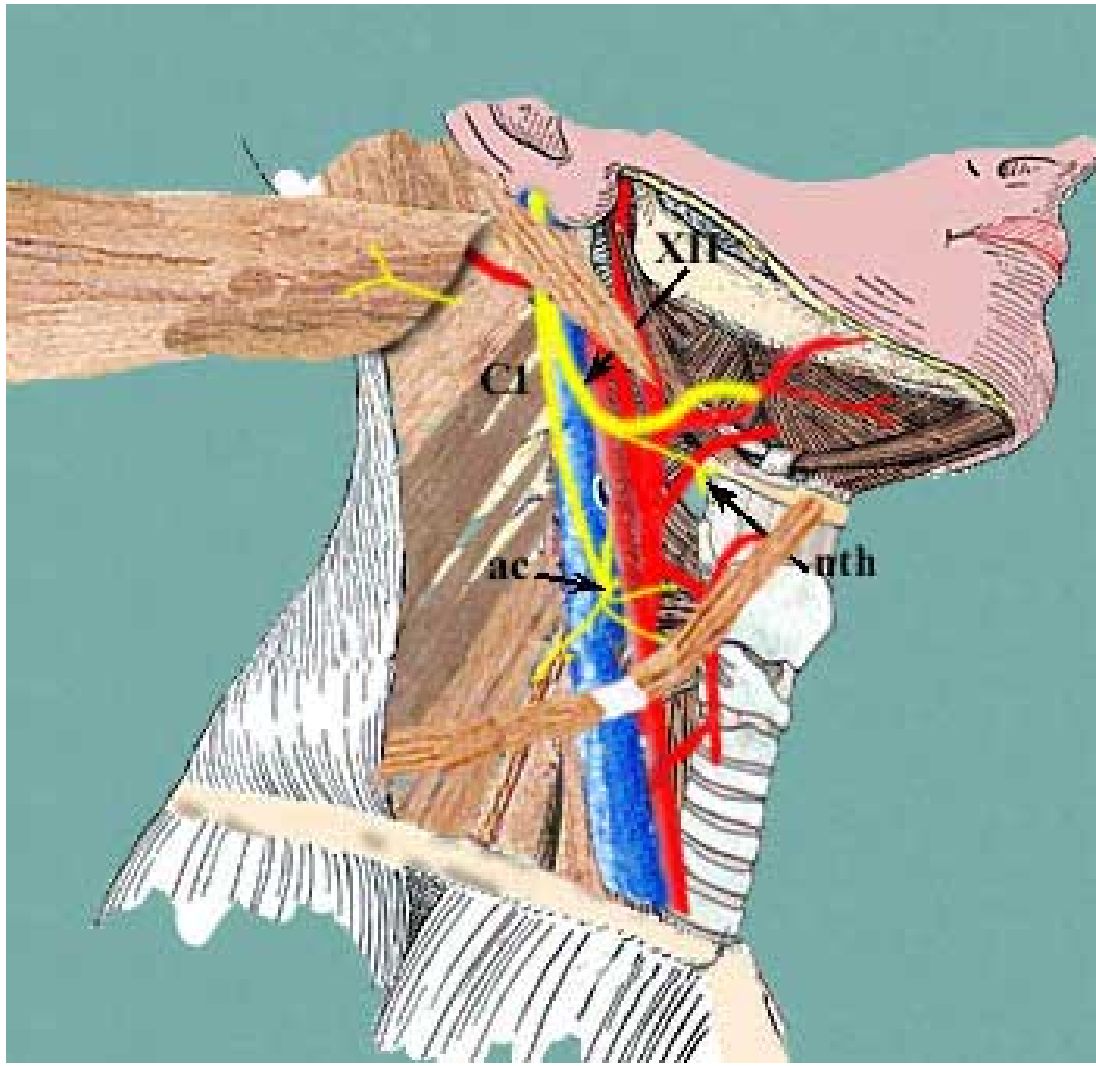
- Fibres from C1 are transported by the hypoglossal nerve to
  - thyrohyoid and geniohyoid
  - forms the superior root of the **ansa cervicalis** with the ansa cervicalis inferior root (derived from C2 & C3)
    - **infrahyoid muscles**
      - omohyoid
      - sternohyoid
      - sternothyroid
      - thyrohyoid
      - geniohyoid



Ansa Cervcalis & Hypglossal

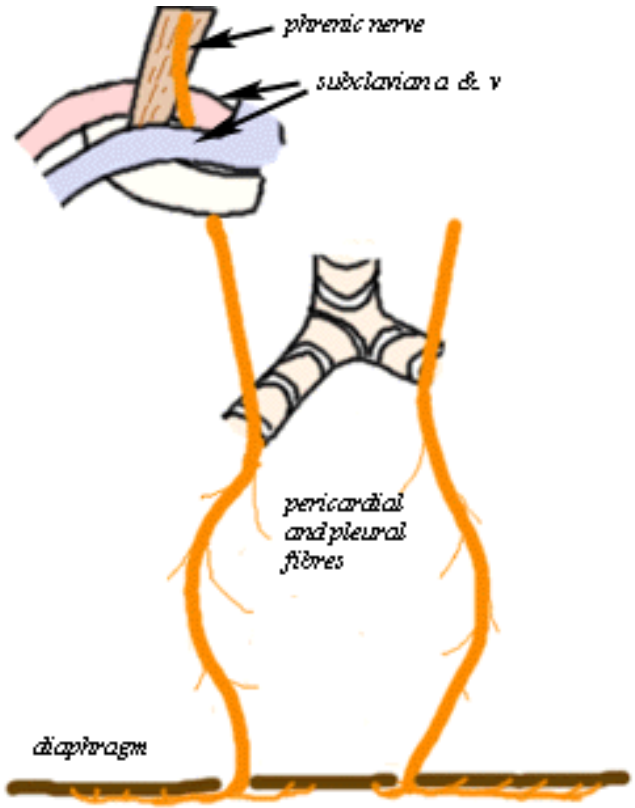
The nerves that enter the carotid triangle and that lie superficial to the internal jugular vein, internal and external carotid arteries are:

- •hypoglossal (XII)
- •C1 root of ansa cervicalis (C1)
- •C1 fibers running with hypoglossal nerve (nerve to thyrohyoid muscle (nth)
- •C2-C3 root of ansa cervicalis
- •ansa cervicalis (ac)



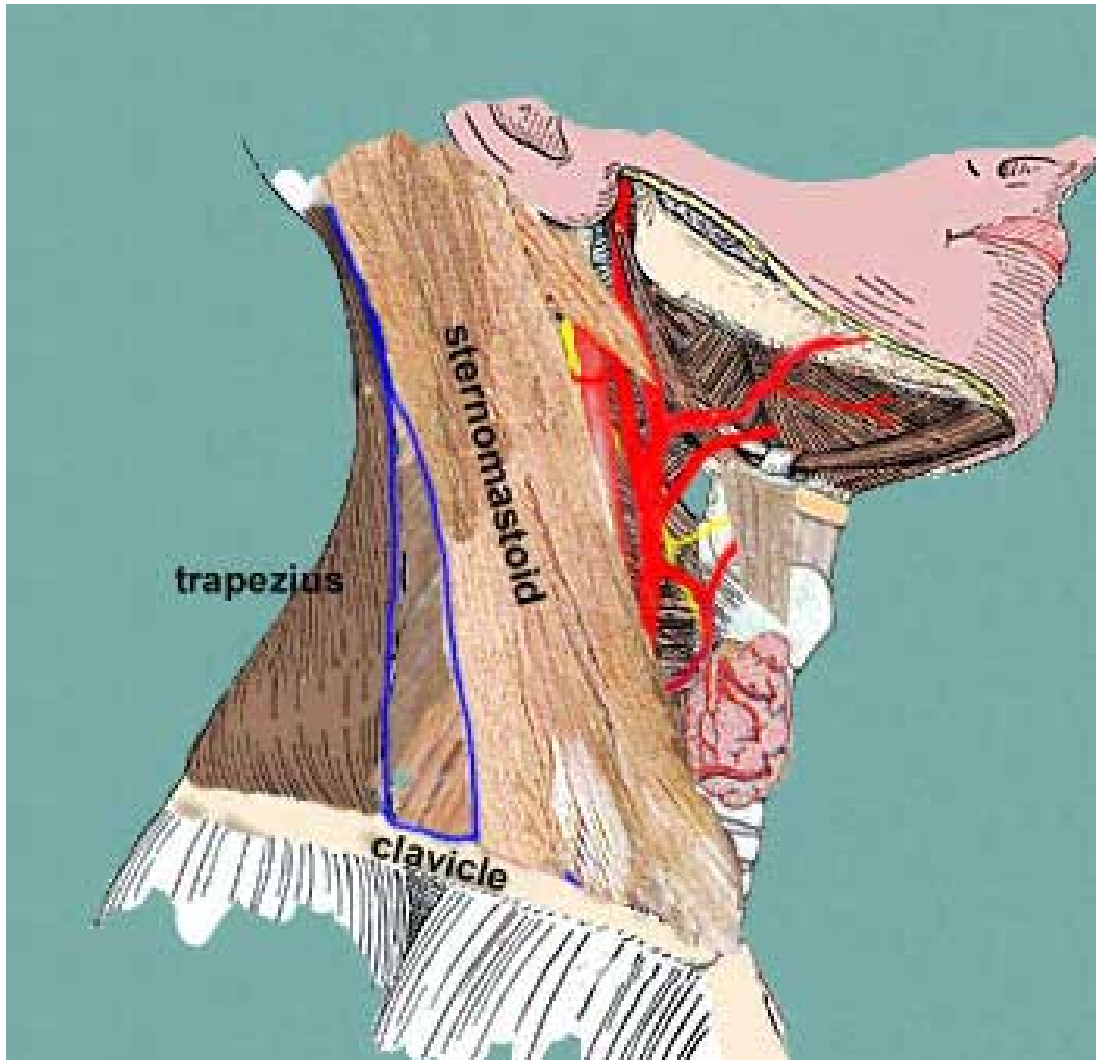
Cervical Plexus (cont)

- **Phrenic Nerve** (C3 & C4 & C5) - Descends through the neck and thorax to supply the diaphragm.
- It lies on the scalenus anterior muscle and enters the thorax between the subclavian artery and the subclavian vein.
- The phrenic nerve is the only nerve to the diaphragm



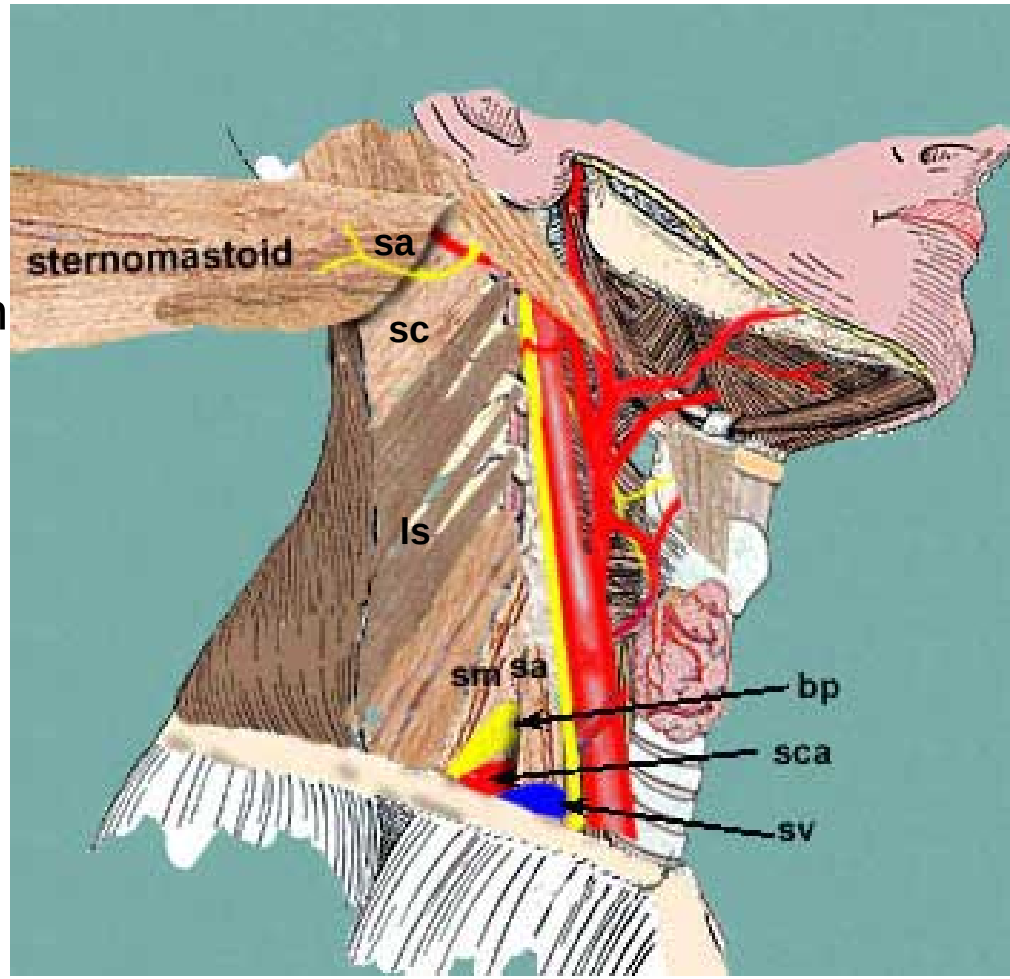
Brachial Plexus Emerges From The Posterior Triangle

- **Posterior triangle--bordered by the posterior border of the SCM, trapezius, and clavicle**



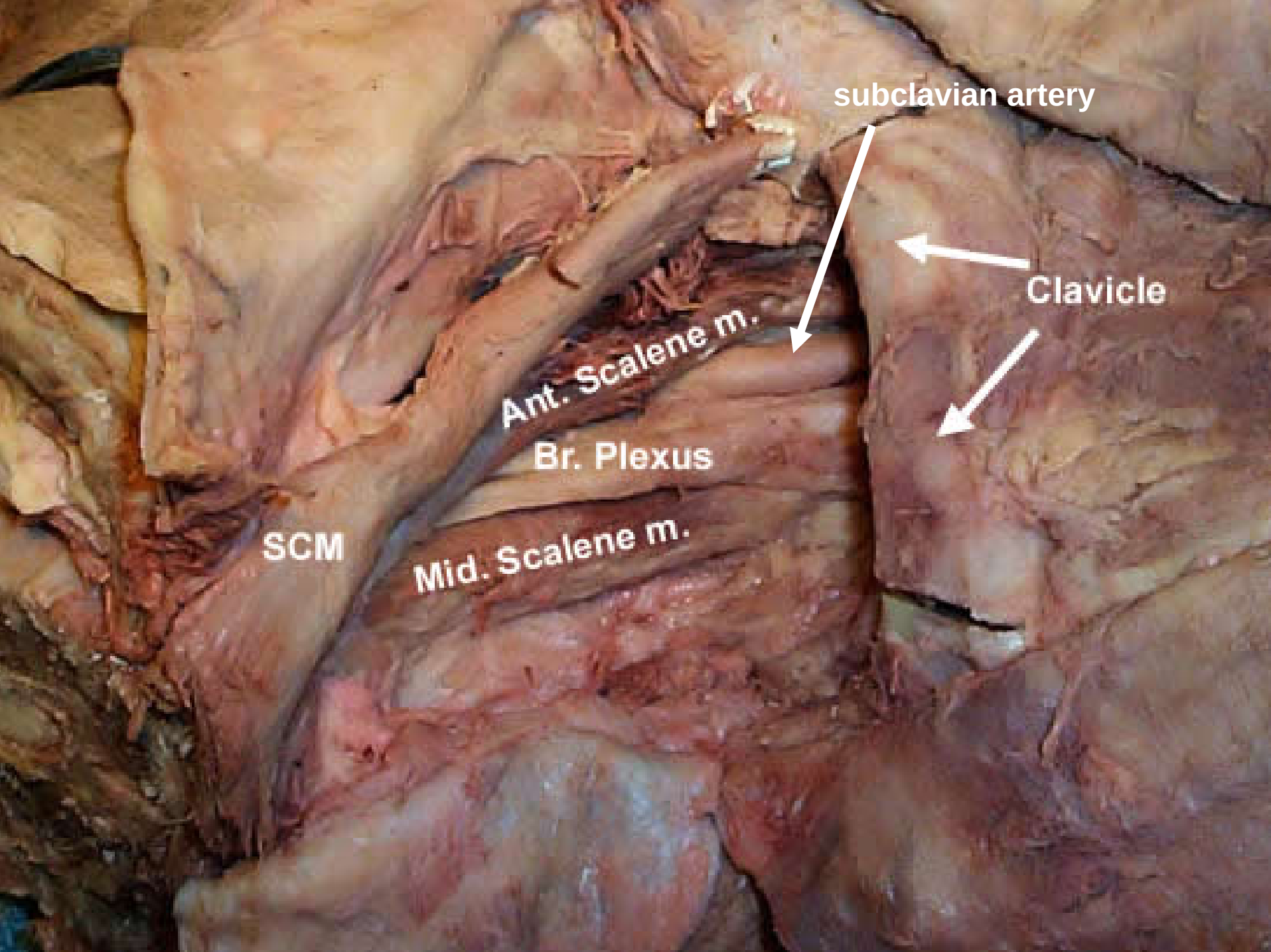
Brachial Plexus

- the **brachial plexus** and subclavian artery **pass between the scalenus anterior (sa) and medius (sm) muscles.** The subclavian vein passes anterior to the scalenus anterior muscle.

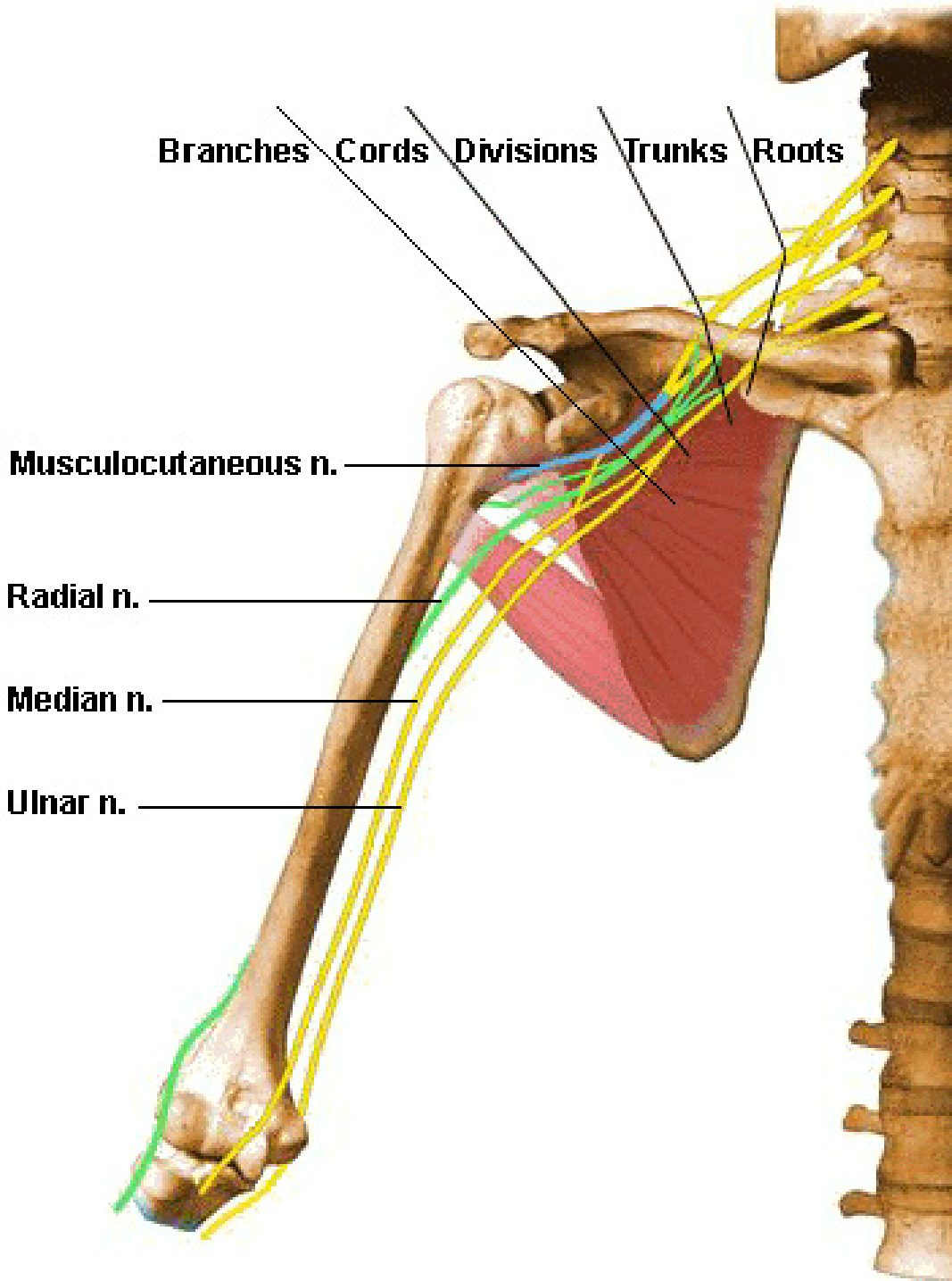


Legend

brachial plexus (bp)
subclavian artery (sca)
subclavian vein (sv)
scalenus anterior (sa)
medius (sm) muscles
levator scapulae (ls)
spinal accessory (sa) nerve

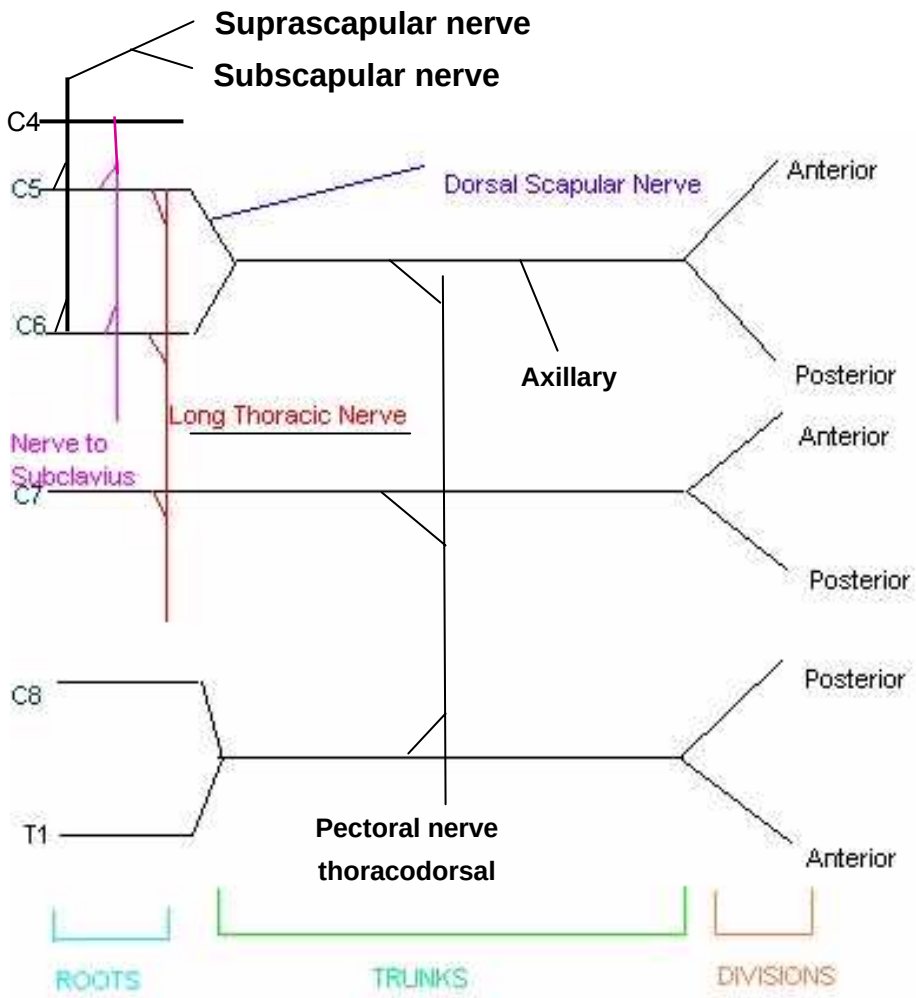

subclavian artery
Clavicle
Ant. Scalene m.
Br. Plexus
SCM
Mid. Scalene m.

- **roots**- fromed by the5 ventral rami (C5-T1)
- five roots unite to form the upper, middle, and lower **trunks**
- Each trunk divide into an anterior and posterior **division**
- the six divisions merge to form three large fiber bundles, the posterior, medial, and lateral **cords**
- cords form 5 major **branches**
  - **axillary**
  - **radial**
  - **musculocutaneous**
  - **median**
  - **ulner**

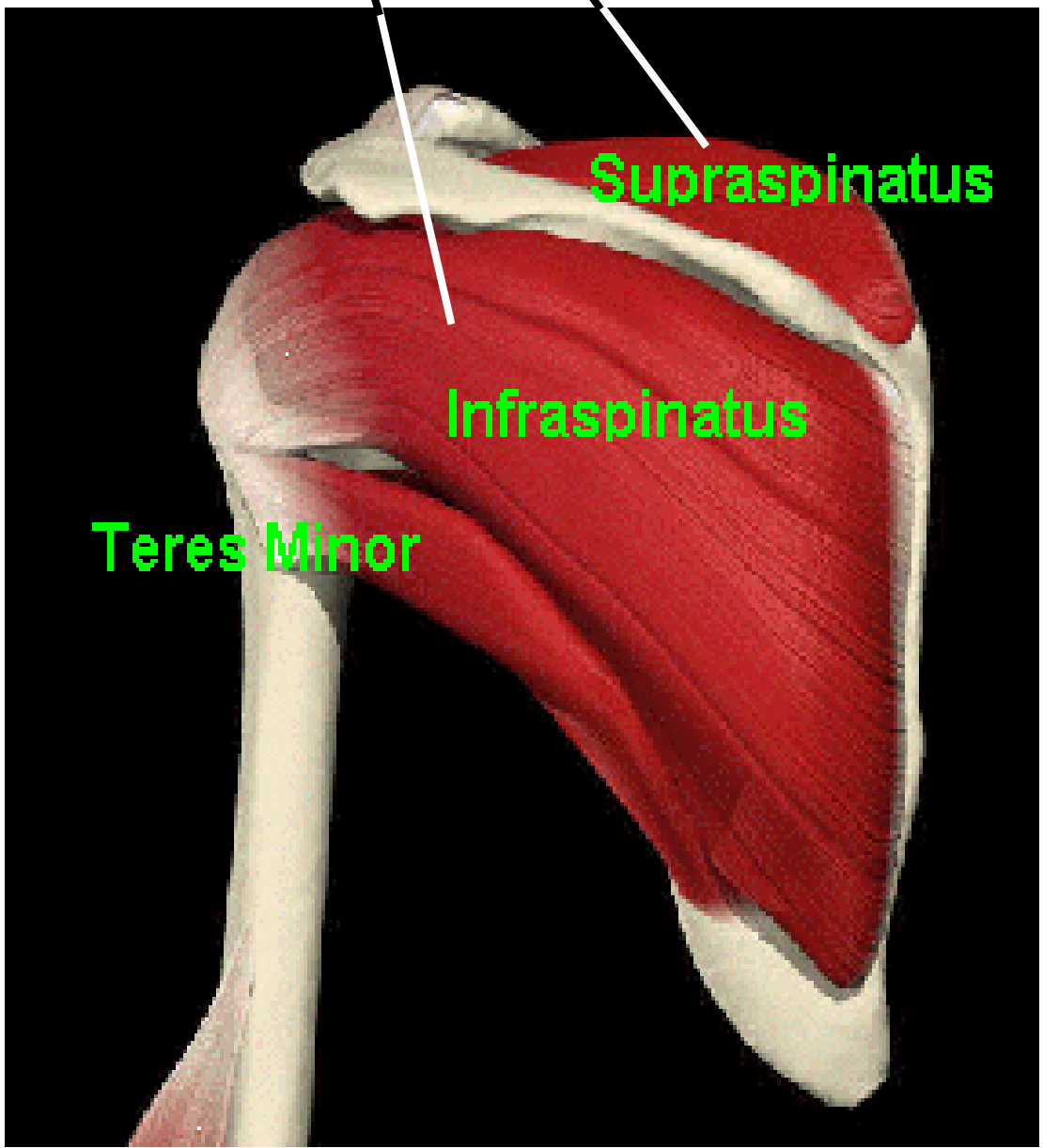


Brachial plexus

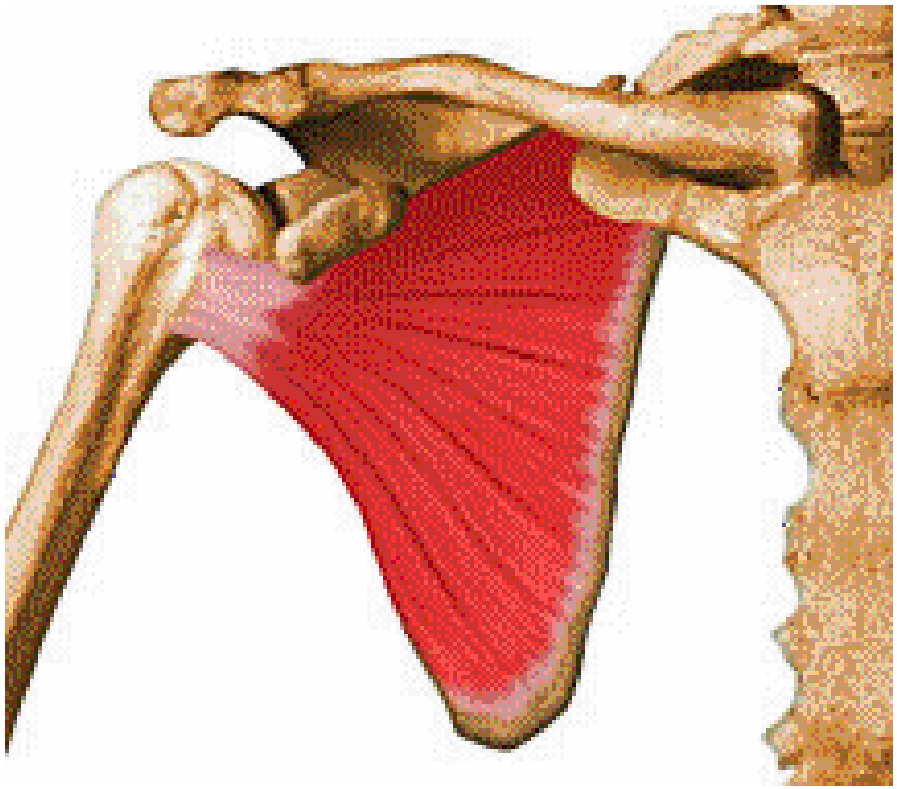
- origin in the posterior triangle of the neck.
- they enter the posterior triangle by emerging from between the interval between scalenus anterior and scalenus medius.
- fromed from the ventral rami of C5, C6, C7, C8, and T1
- Along with the subclavian artery, the brachial plexus acquires a sheath, the axillary sheath.



Suprascapular Nerve (C5, C6)



Subscapular Nerves (Upper & Lower C5, C6)



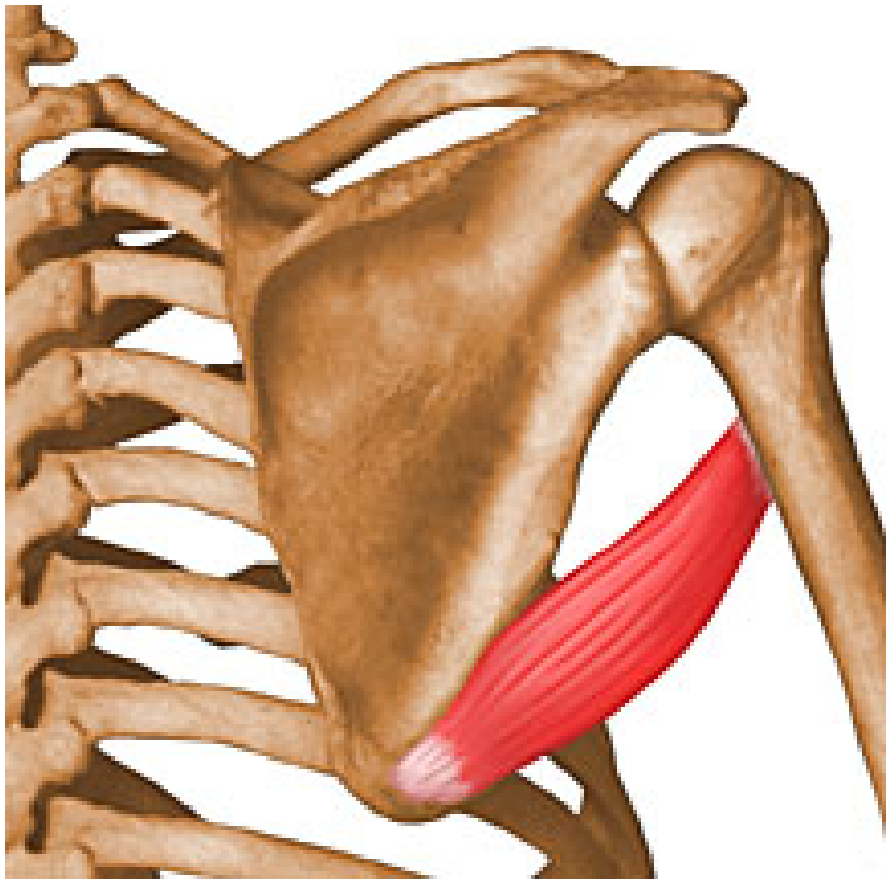
Subscapularis Muscle

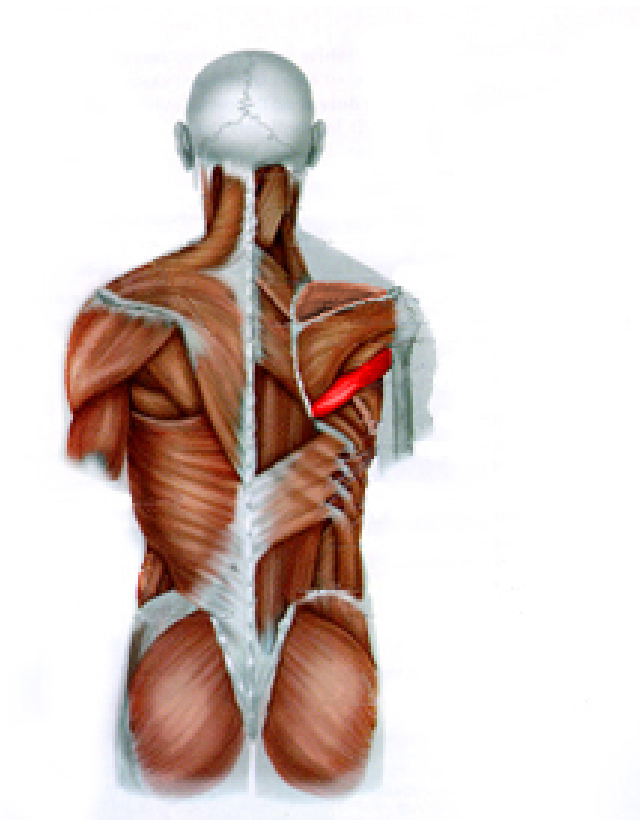
Upper subscapular nerve passes directly into the upper part of *subscapularis muscle*

Lower subscapular nerve divides into 2 branches;

- one enters the lower part of the *subscapularis muscle* and the other continues to *teres major*

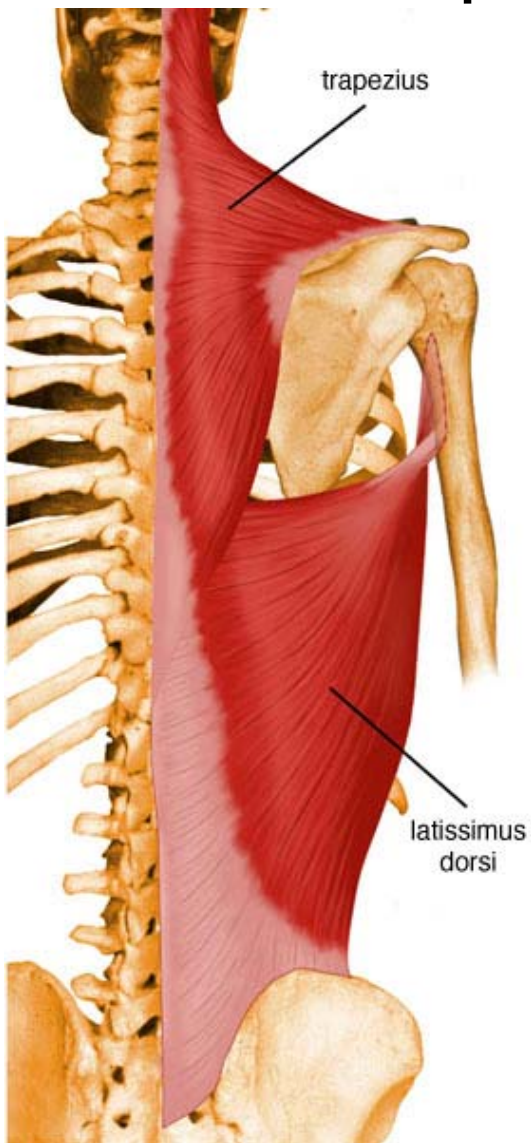
Lower Subscapular Nerve





Teres Major (and subscaplularis)

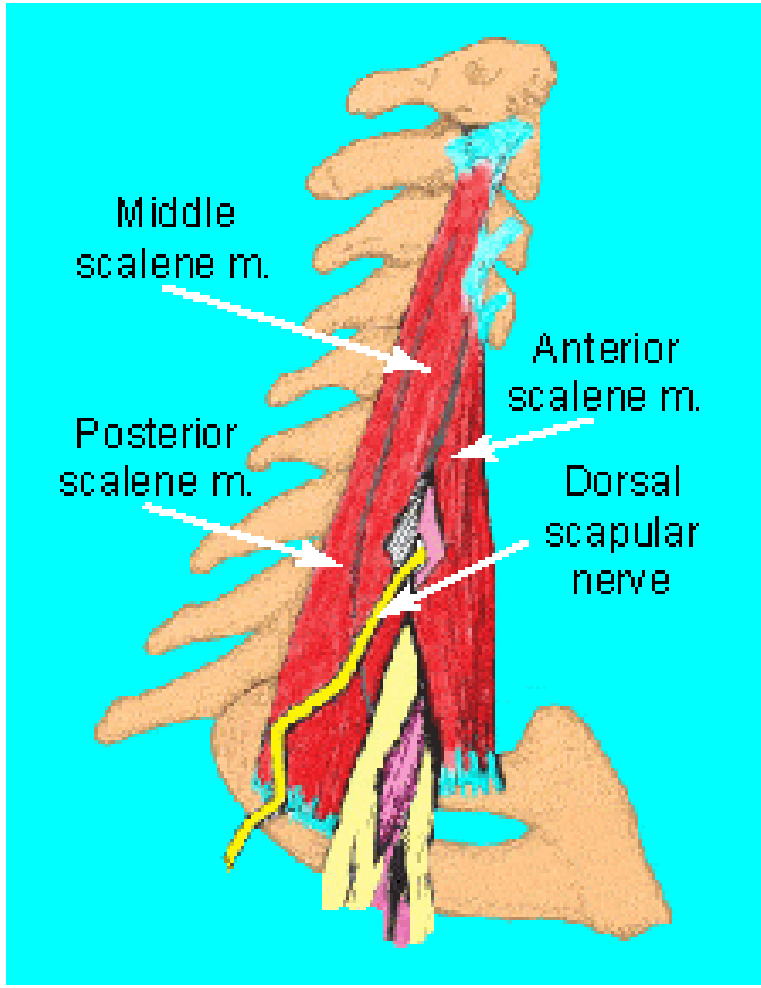
Thoracodorsal Nerve (C6-C8)
(Middle Subscapular)

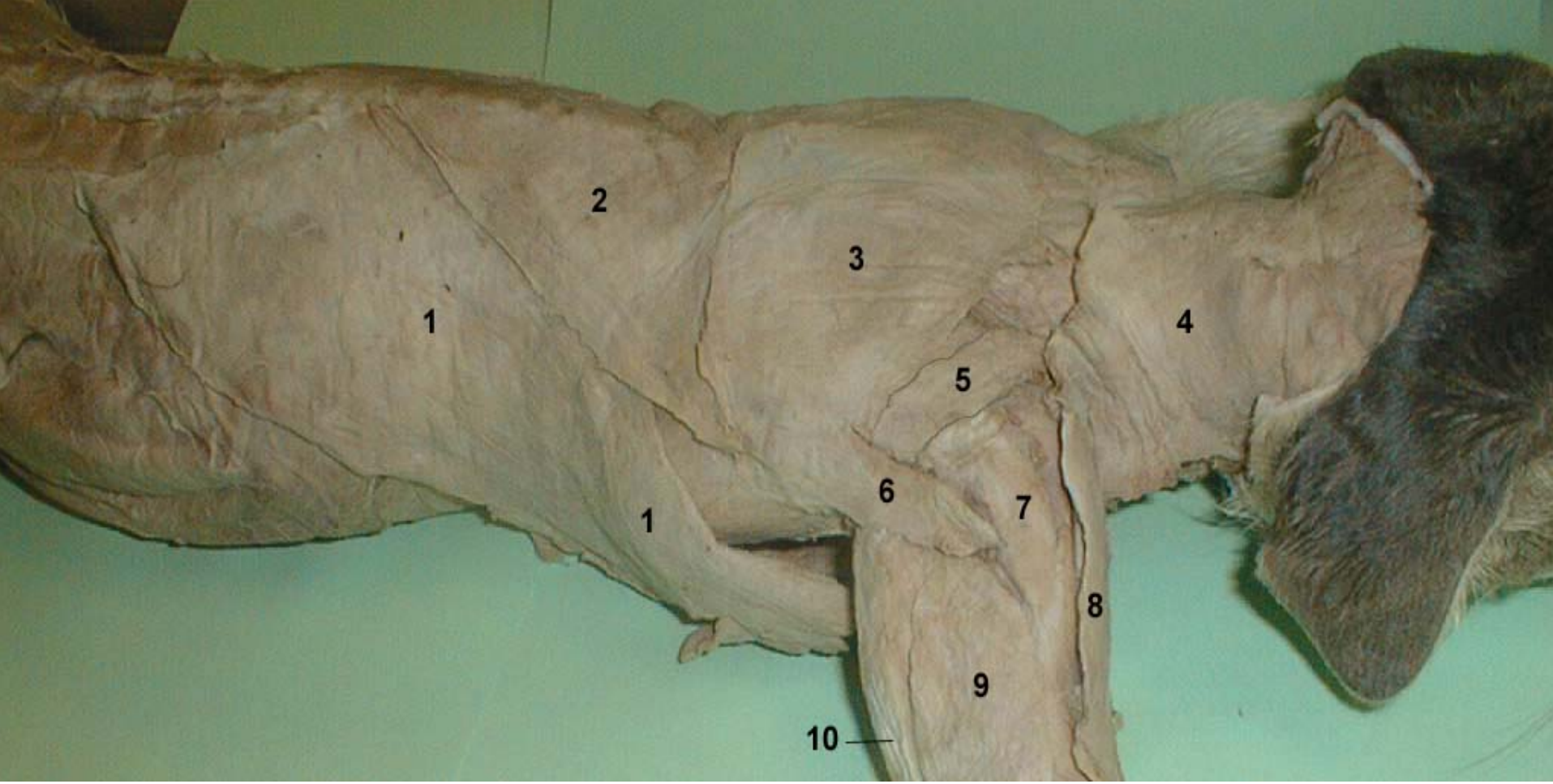


Latissimus dorsi

Dorsal Scapular Nerve

- arises predominately from the 5th cervical nerve and may receive contribution from C4 and C6.
- The nerve is purely motor, with no sensory fibers.
- It enters the interscalene triangle and almost immediately
  - pierces the scalenus medius muscle, running dorsally and caudally to
  - supply the **rhomboid major and minor** muscles and a
  - portion of the **levator scapula**. The levator scapula receives additional nerve supply from the 3rd and 4th cervical nerves.



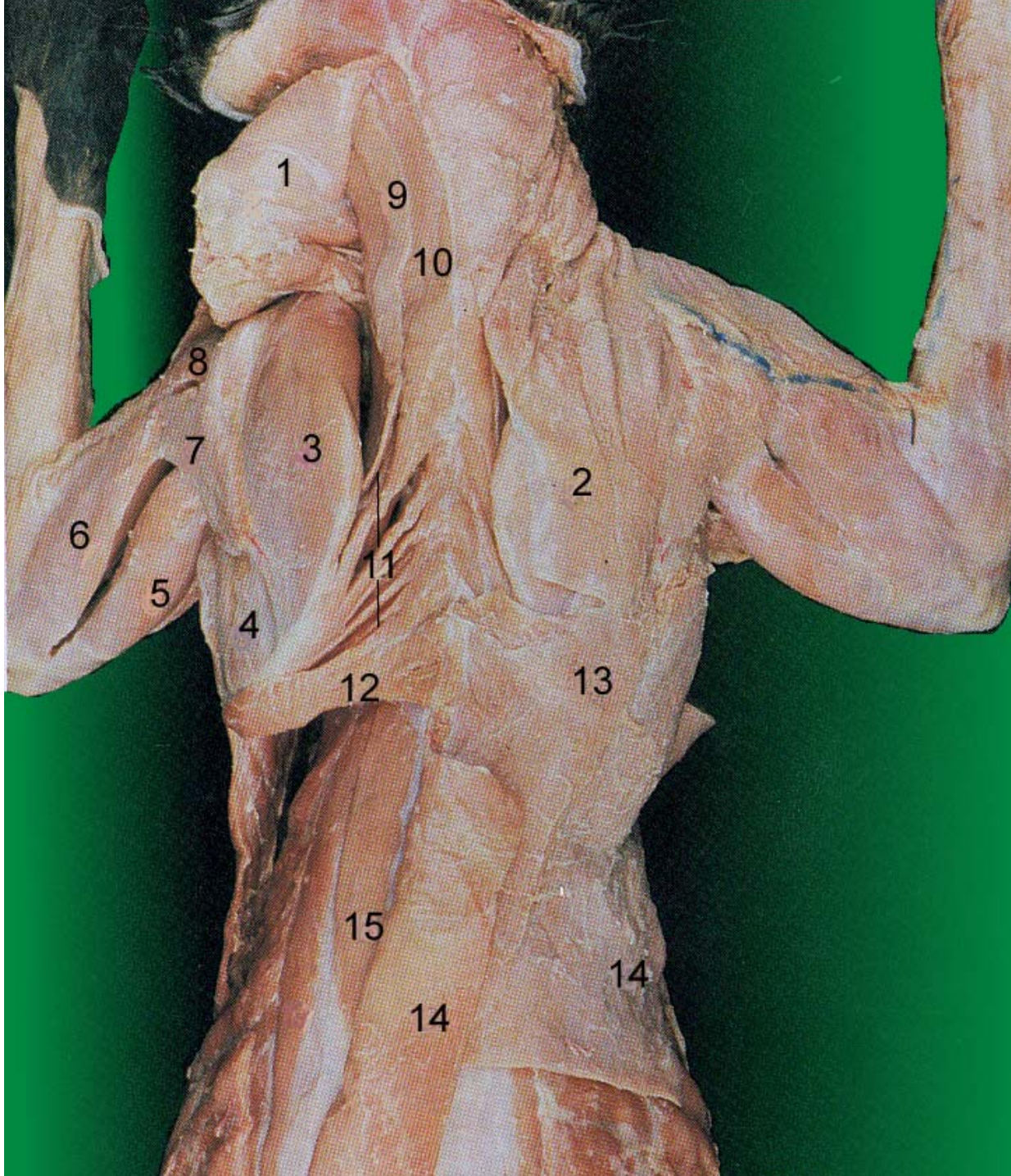


1.Latissimus Dorsi, 2. Spinotrapezius, 3. Acromiotrapezius, 4. Clavotrapezius

5.Levator Scapulae Ventralis, 6.Spinodeltoid, 7.Acromiodeltoid, 8.Clavodeltoid,

9.Triceps Lateral Head, 10.Triceps Long Head

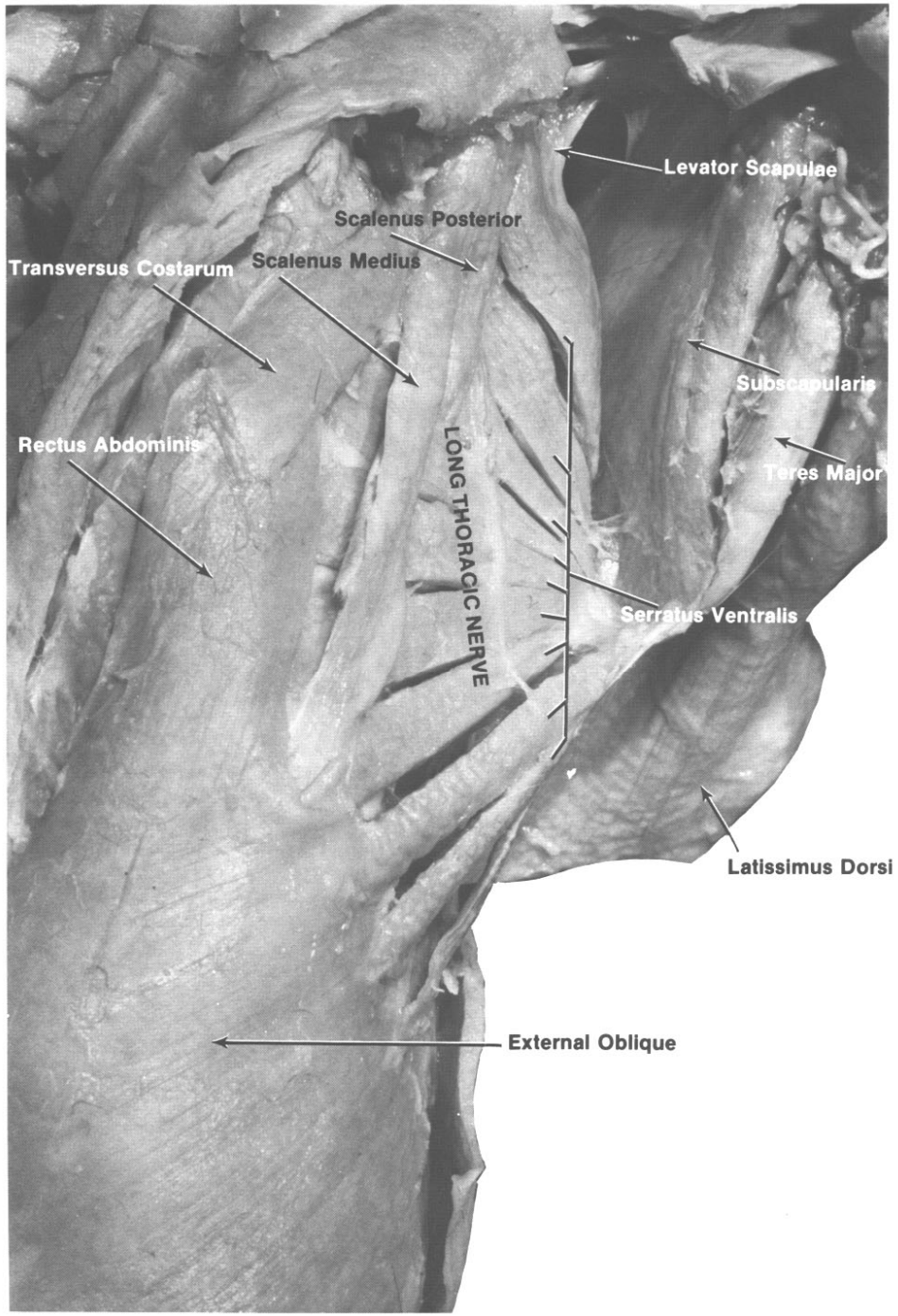
1.Clavotrapezius (Reflected),
2. Acromiotrapezius,
3. Supraspinatus,
4. Infraspinatus,
5.Triceps (Long Head),
6.Triceps (Lateral Head),
7. Acromiodeltoid,
8.Clavodeltoid,
9.Rhomboideus Capitis,
10.Splenius Capitis,
11.Rhomboideus Minor,
12.Rhomboideus Major,
13.Spinotrapezius,
14.Latissimus Dorsi,
15.Longissimus



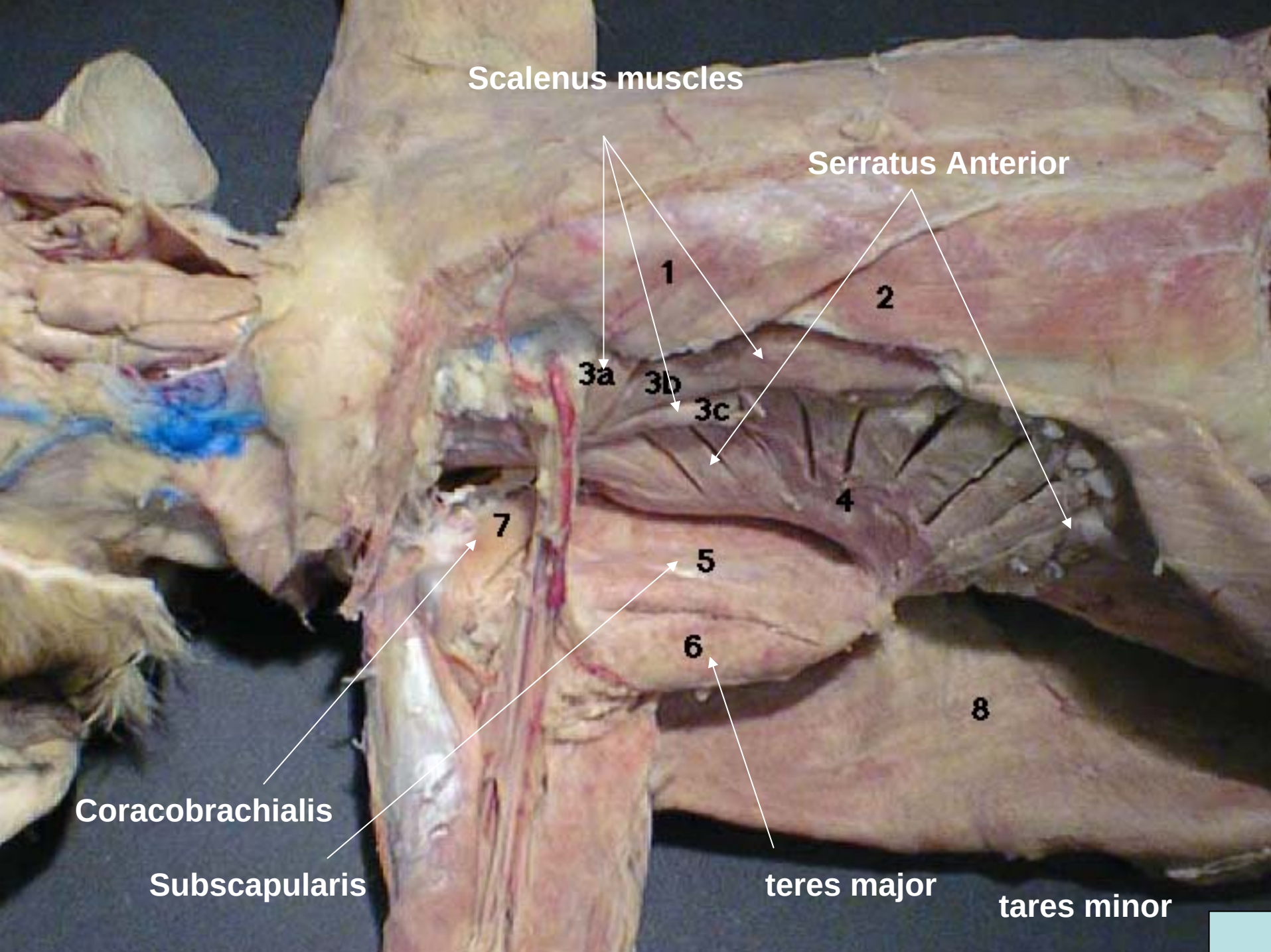
Long Thoracic Nerve

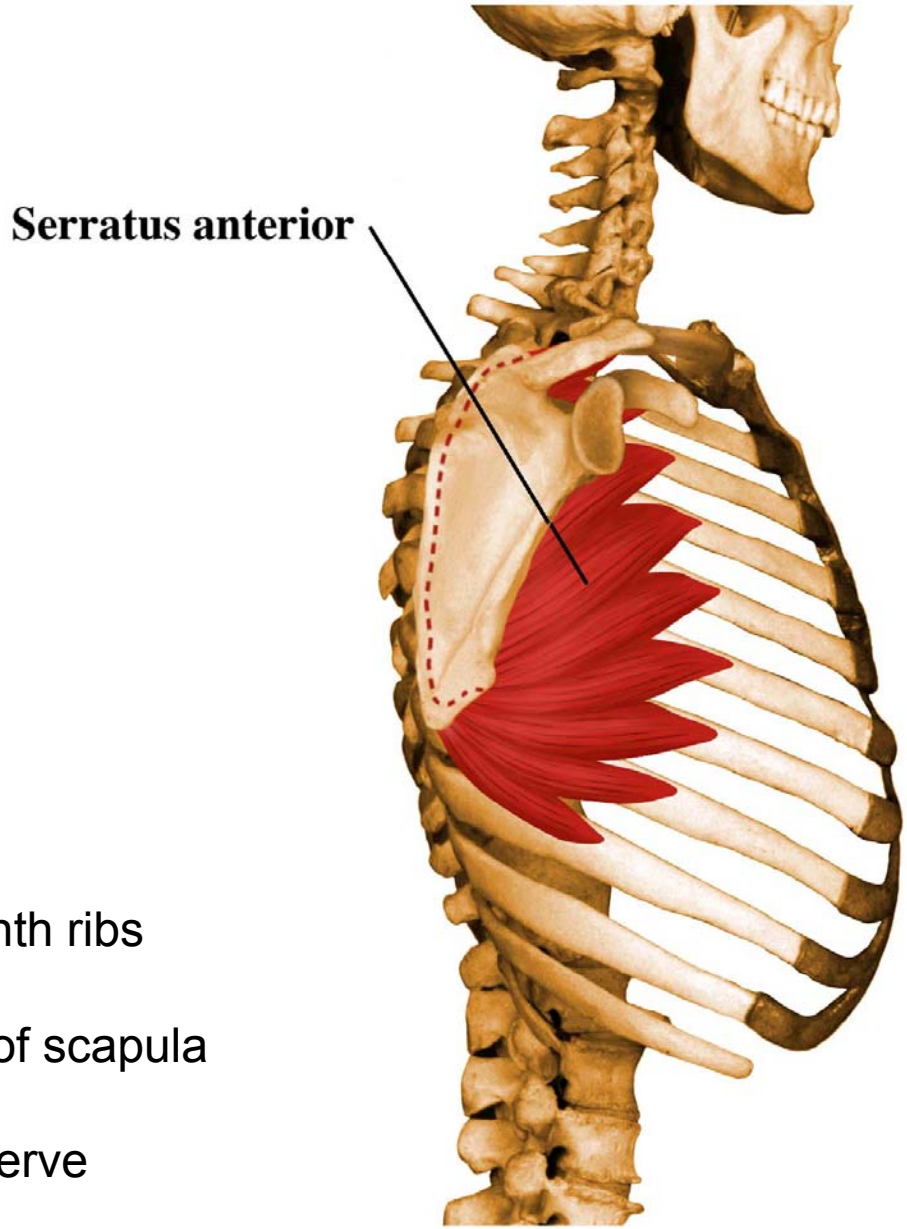
Nerve Origin: Direct branch from C5, C6, C7 roots

Muscles Innervated: **Serratus Anterior**



DEEP MUSCLES - THORAX AND SHOULDER, VENTRAL VIEW

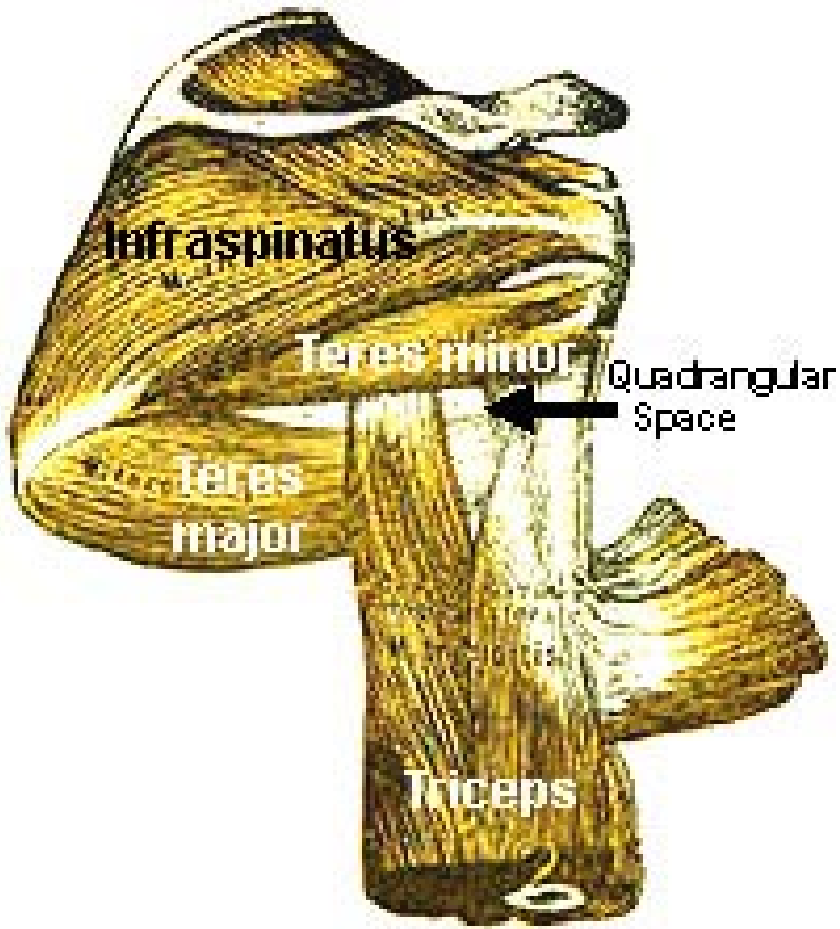

Scalenus muscles
Serratus Anterior
1
2
3a
3b
3c
4
5
6
7
8
Coracobrachialis
Subscapularis
teres major
tares minor

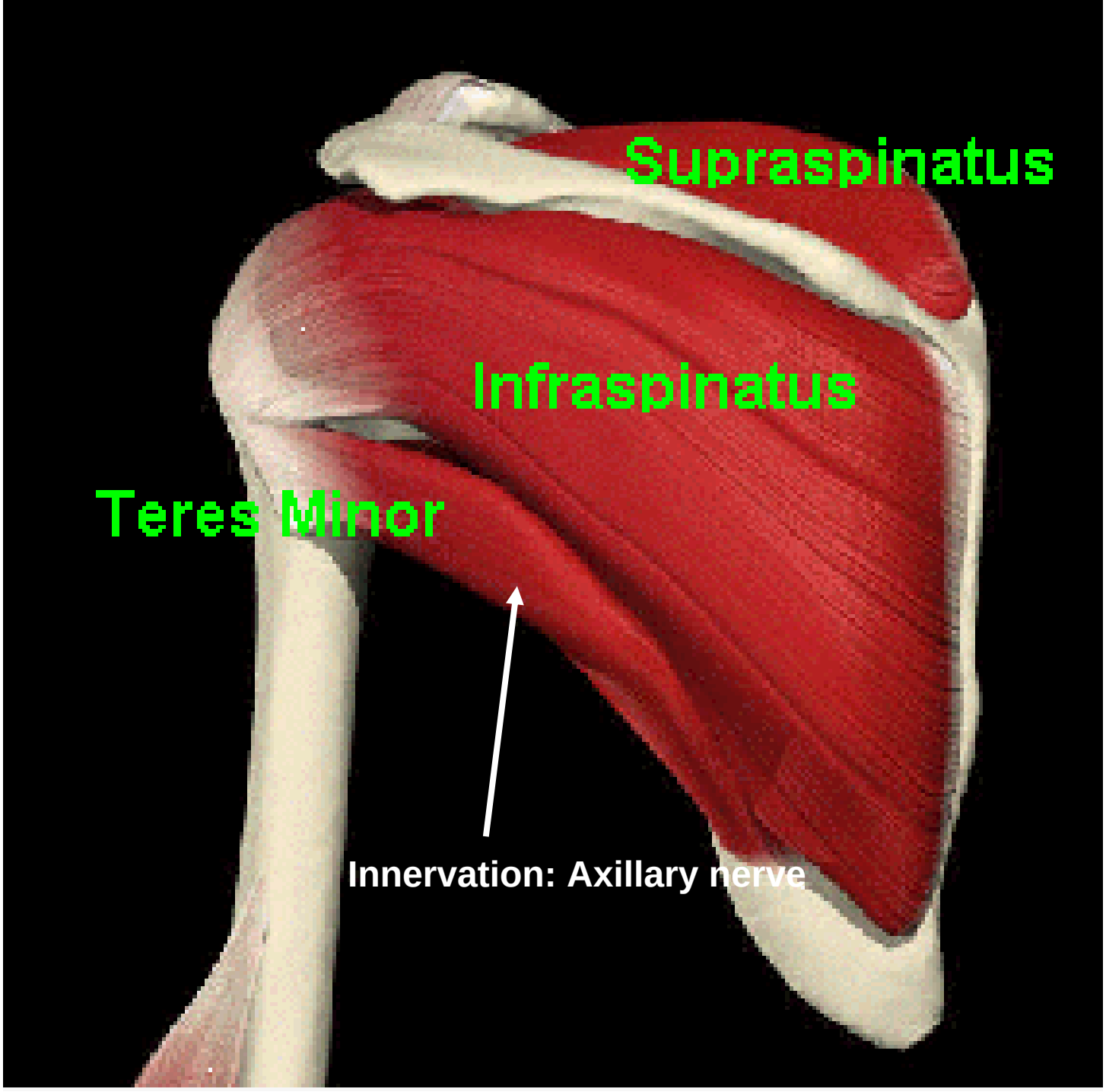


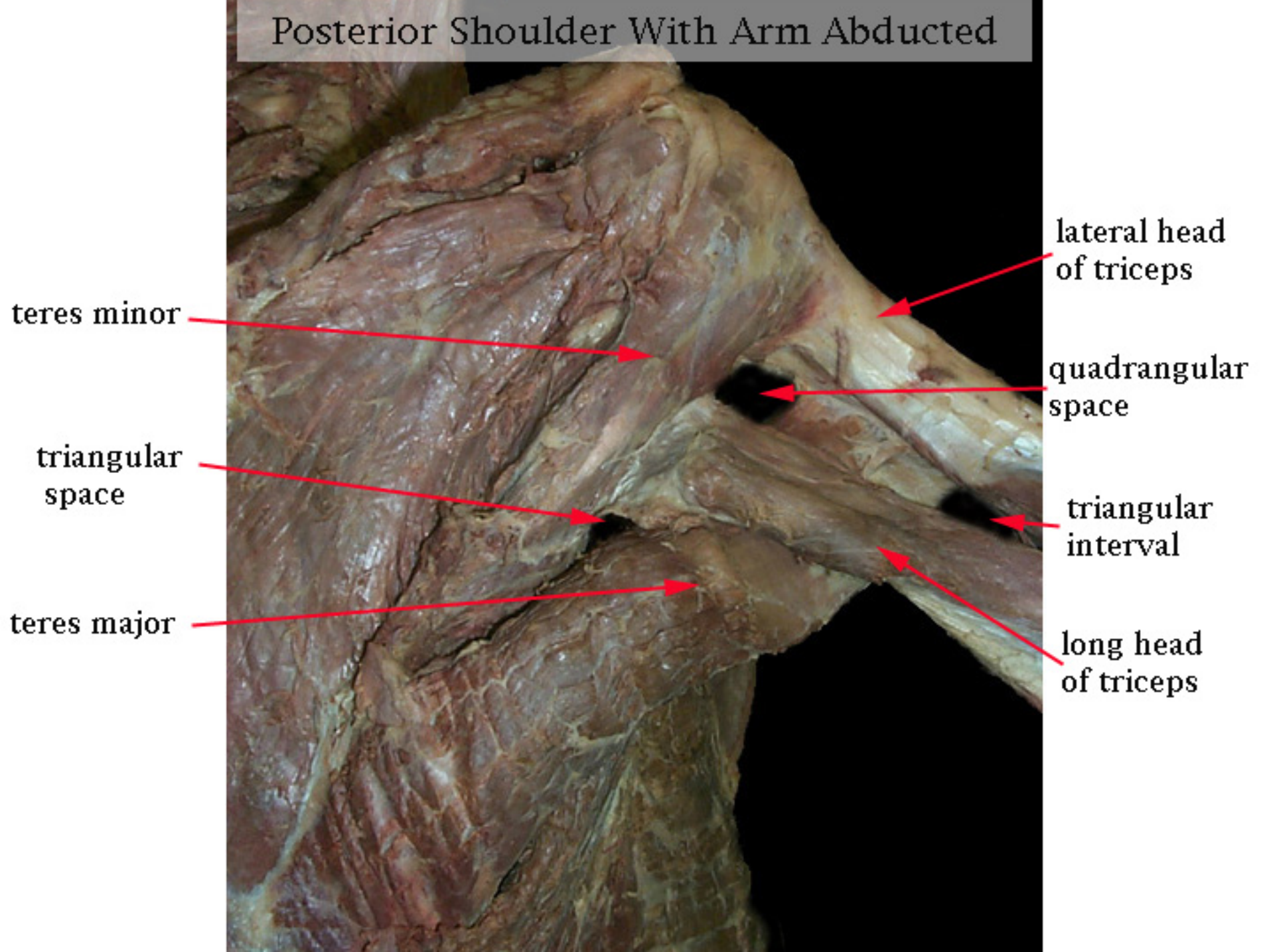
Origin:
first through ninth ribs
Insertion:
medial border of scapula
Innervation:
long thoracic nerve

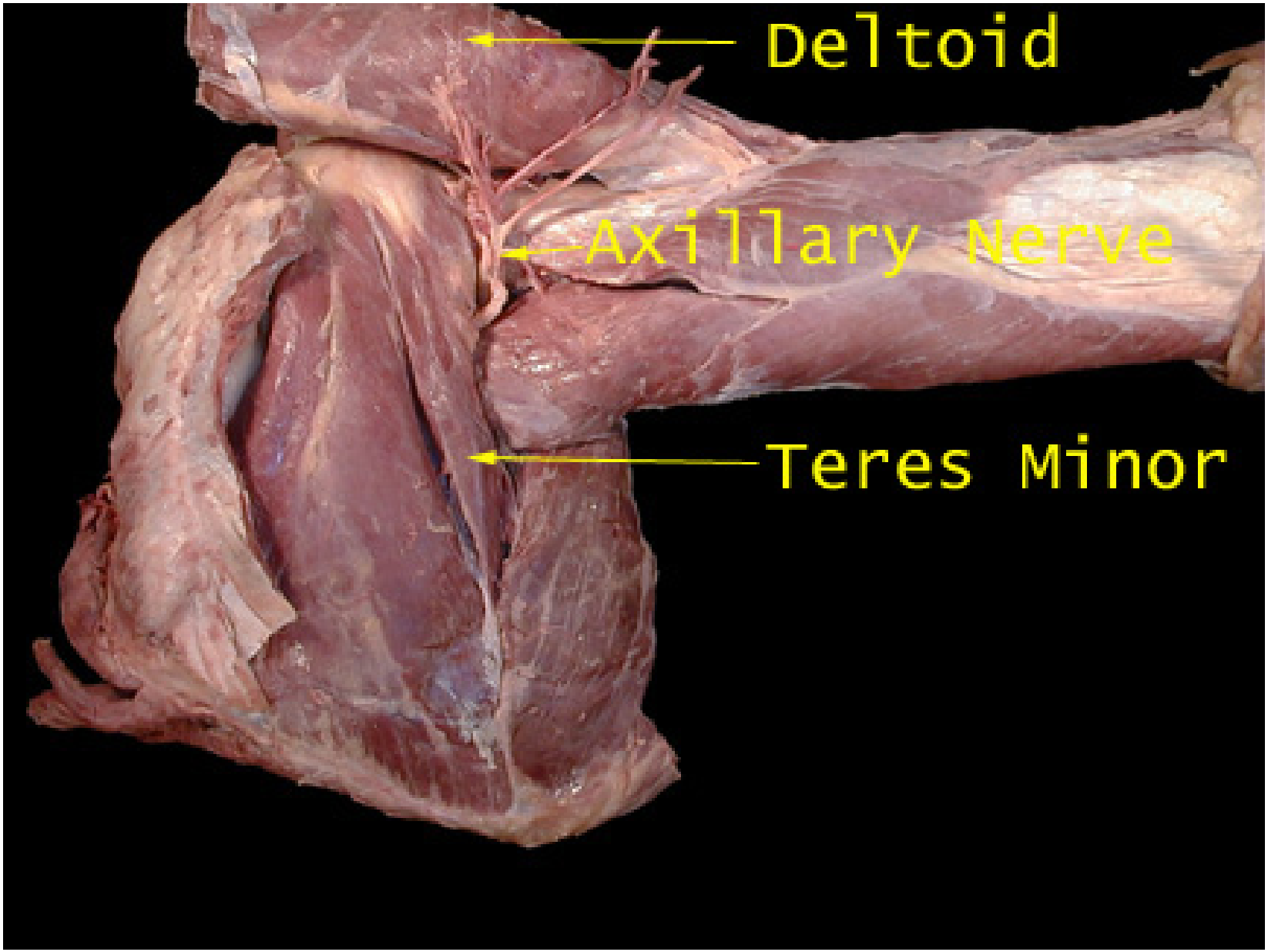
Axillary Nerve: C5, C6

- In the axilla on each side, the **quadrangular space** is bounded by:
- superiorly:
  - and ventrally: subscapularis
  - and dorsally: teres minor
- inferiorly: teres major
- medially: long head of triceps
- laterally: humerus
- It transmits the:
  - **axillary nerve**
  - posterior circumflex humeral artery
  - posterior circumflex humeral vein
- muscles innervated
  - **teres minor**
  - **deltoid**
- origin
  - posterior division of the trunks of the brachial plexus

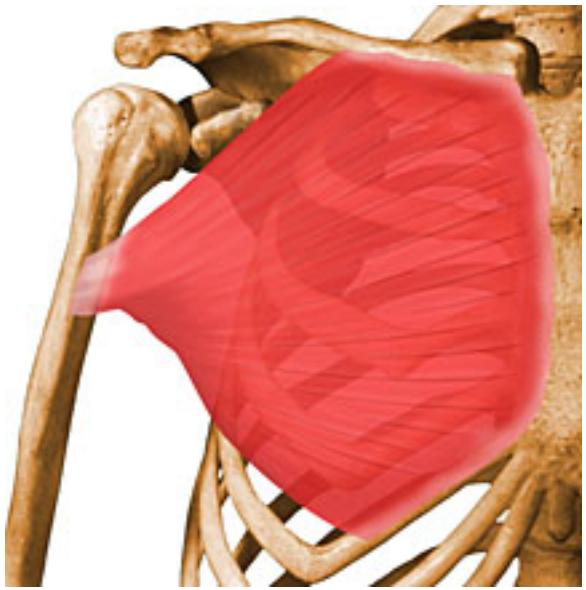



Supraspinatus
Infraspinatus
Teres Minor
Innervation: Axillary nerve

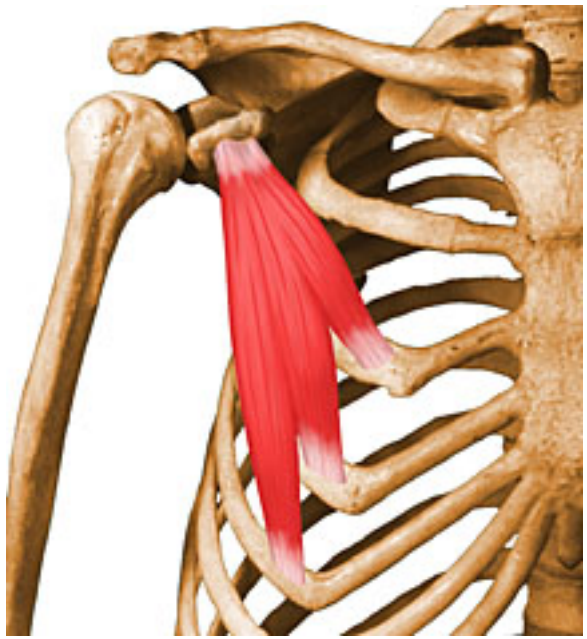

Posterior Shoulder With Arm Abducted
lateral head of triceps
teres minor
quadrangular space
triangular space
triangular interval
teres major
long head of triceps


Deltoid
Axillary Nerve
Teres Minor

Pectoral Nerves (Medial & Lateral)



Pectoralis Major

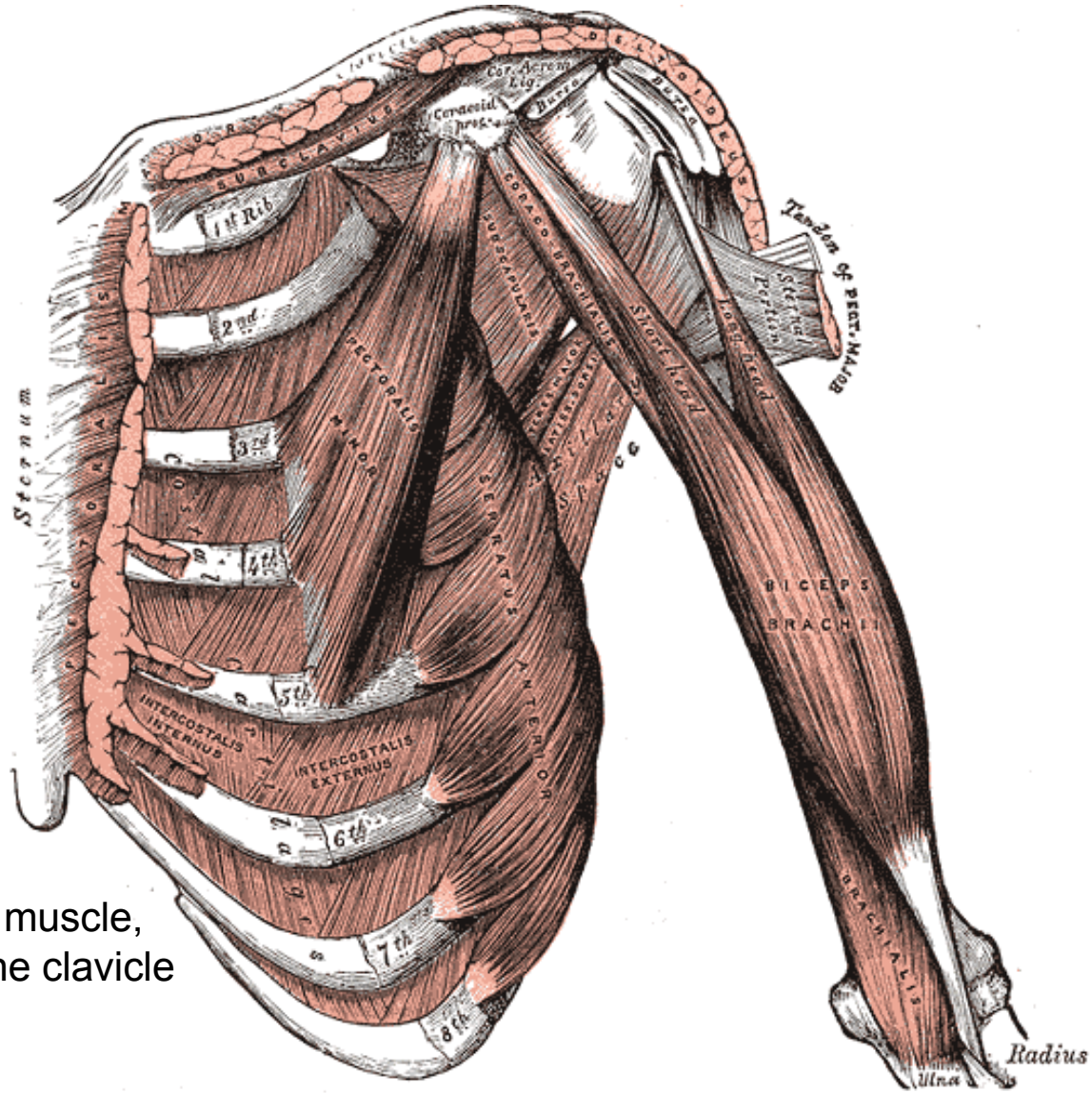


Pectoralis minor

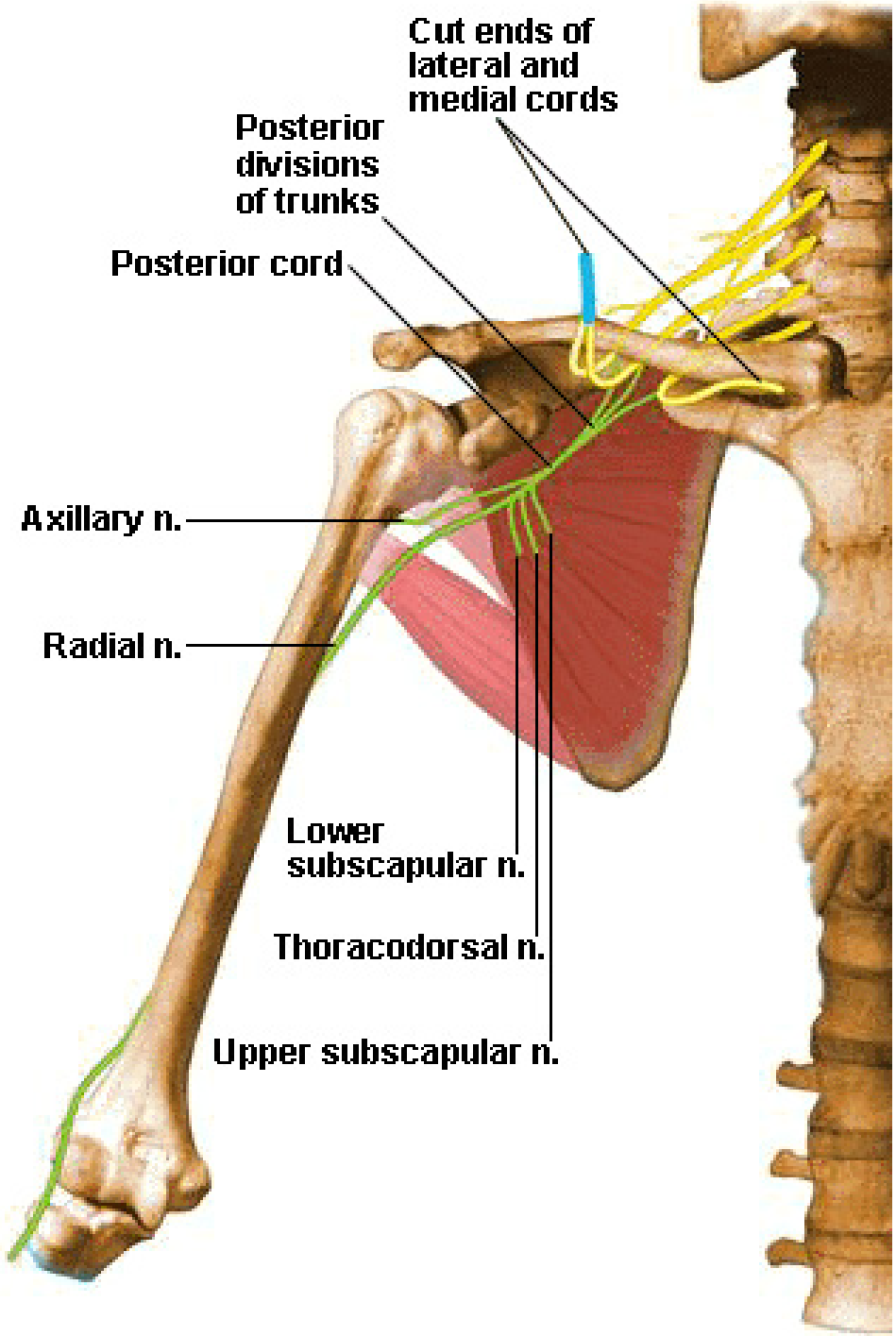
Thoracodorsal Nerve (C6-C8)

Latissimus dorsi

Nerve to the Subclavius (C4-C6)



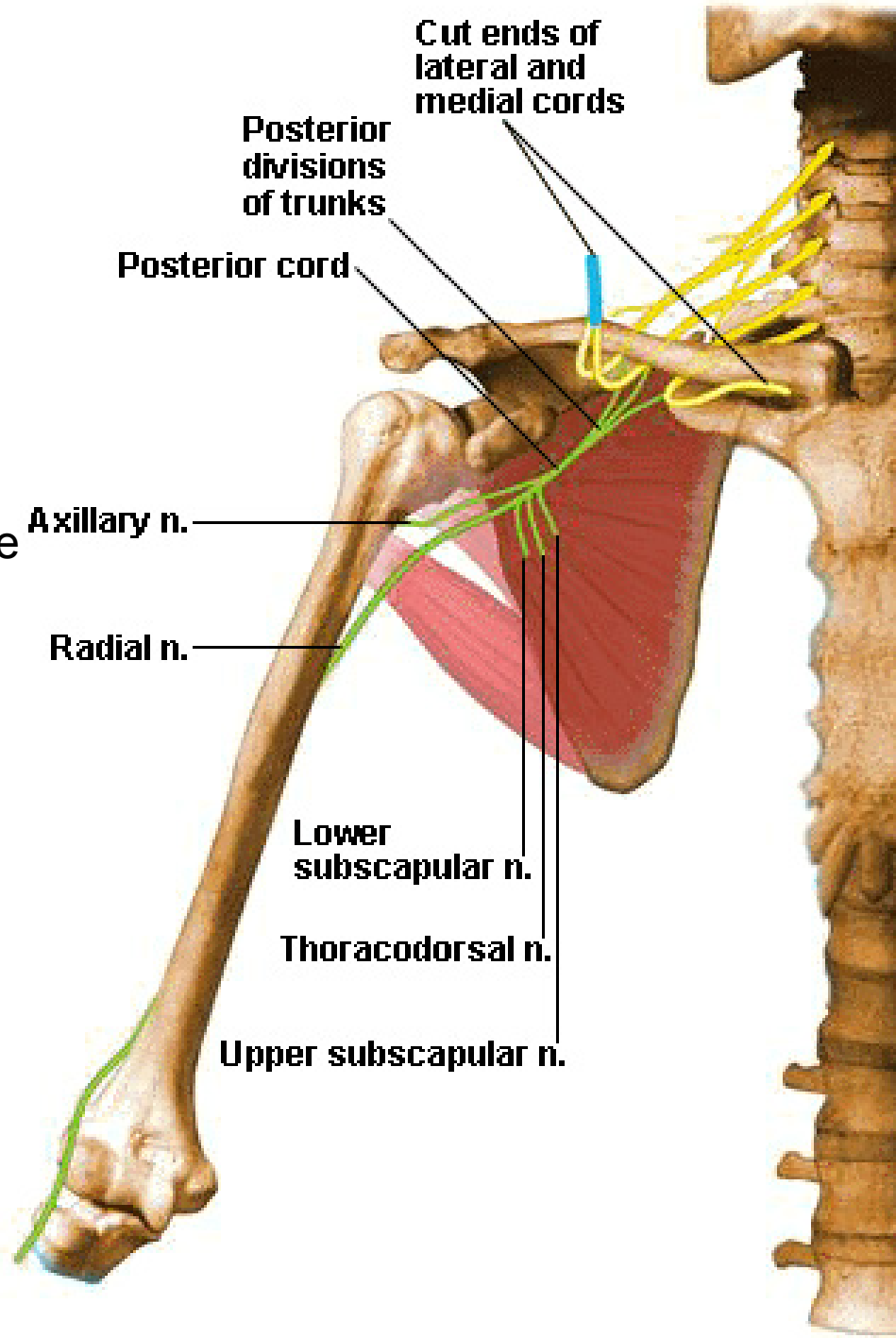
A small triangular muscle, placed between the clavicle and the first rib.


Cut ends of lateral and medial cords
Posterior divisions of trunks
Posterior cord
Axillary n.
Radial n.
Lower subscapular n.
Thoracodorsal n.
Upper subscapular n.

Radial Nerve

•Arises from the posterior cord of the brachial plexus, (C5,C6)

•It passes out of the posterior axilla between the long head of triceps and the humerus to run in the spiral groove on the back of the humerus, along with the brachial artery.



Radial Nerve

Formed from posterior cord

Supplies triceps and passes behind humerus in spiral groove

lies between brachioradialis and brachialis at elbow

gives off superficaial and deep terminal branches

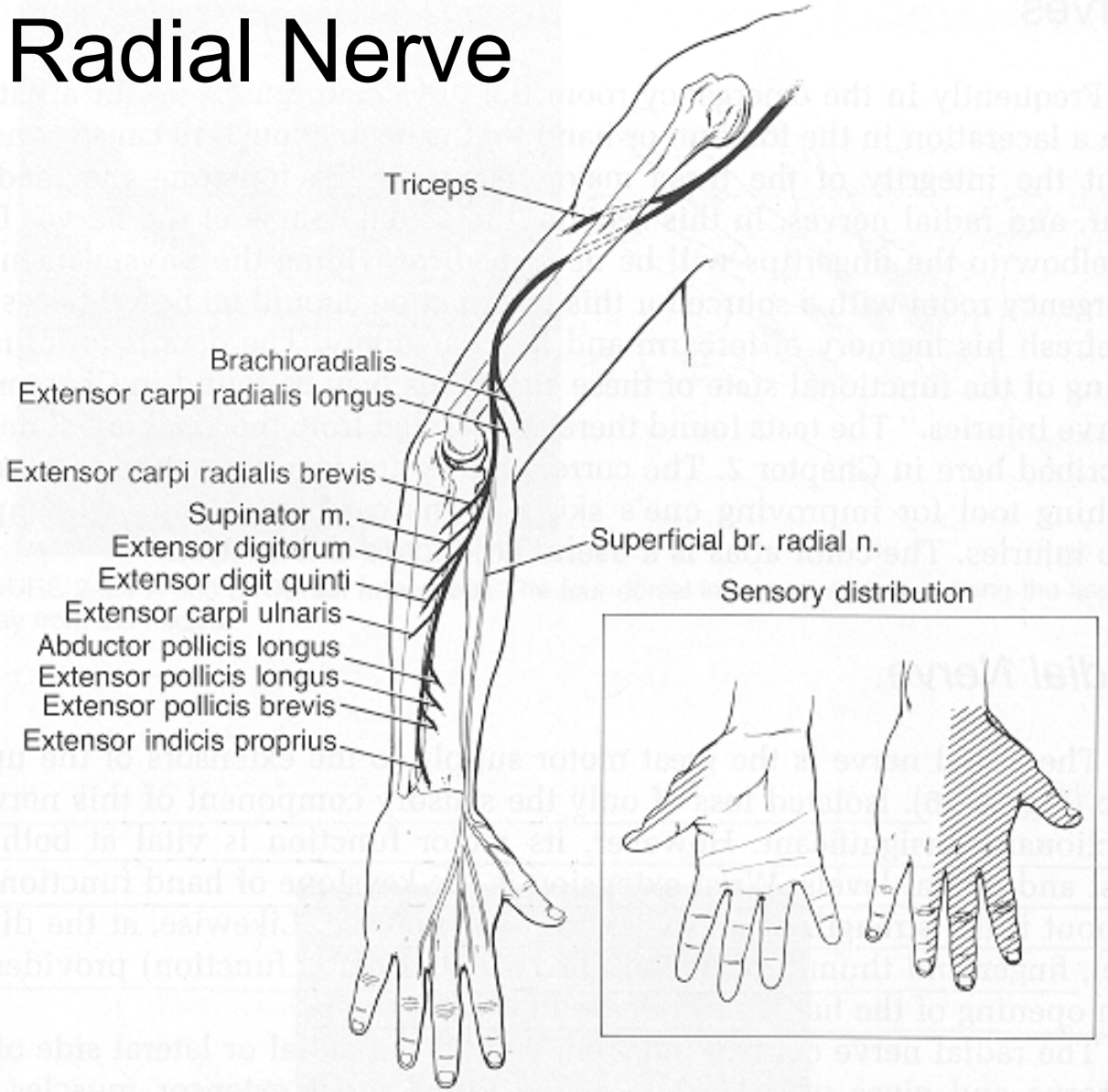
pronated

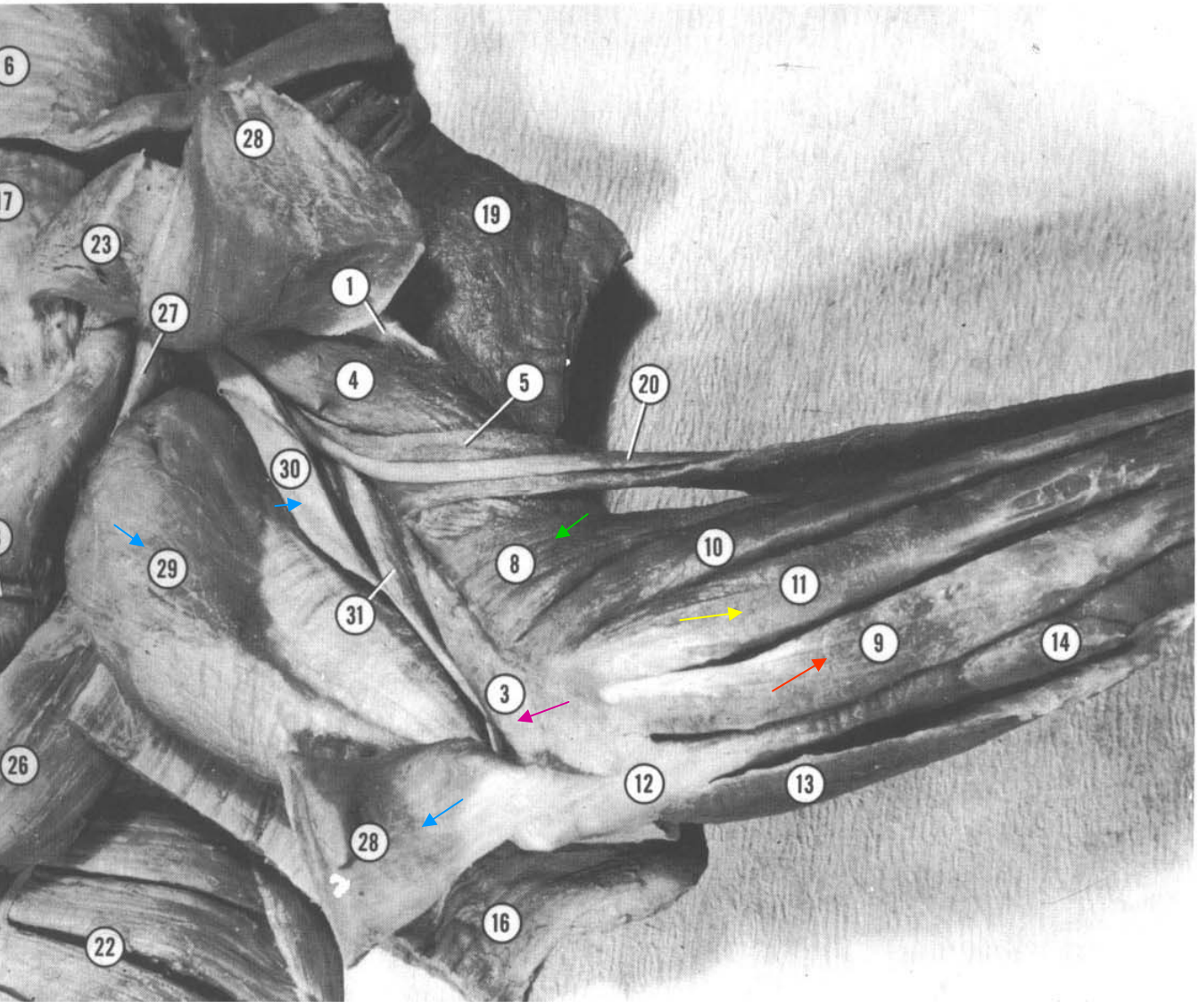
Radial Nerve

• The radial nerve gives off motor branches **above** the elbow to innervate the, triceps brachii, **extensor carpi radialis longus, anconeus,** and **brachioradialis**

• the radial nerve branches just above (or just below) the elbow into two branches:-

•the **<u>superficial branch of the radial nerve</u>** that courses with the radial artery and supplies **sensation to the dorsum of the radial hand + motor branch to the extensor carpi radialis brevis**;

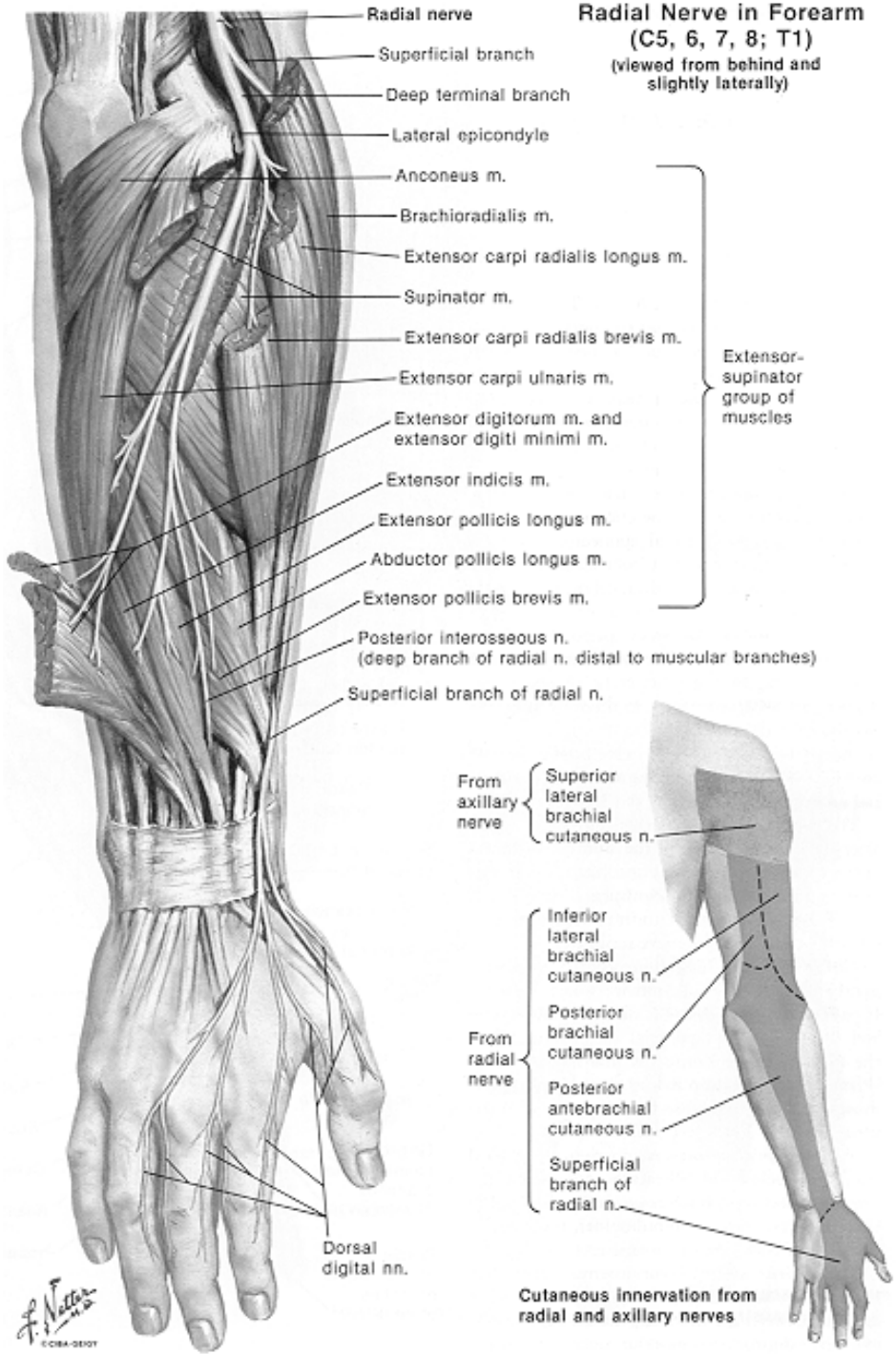




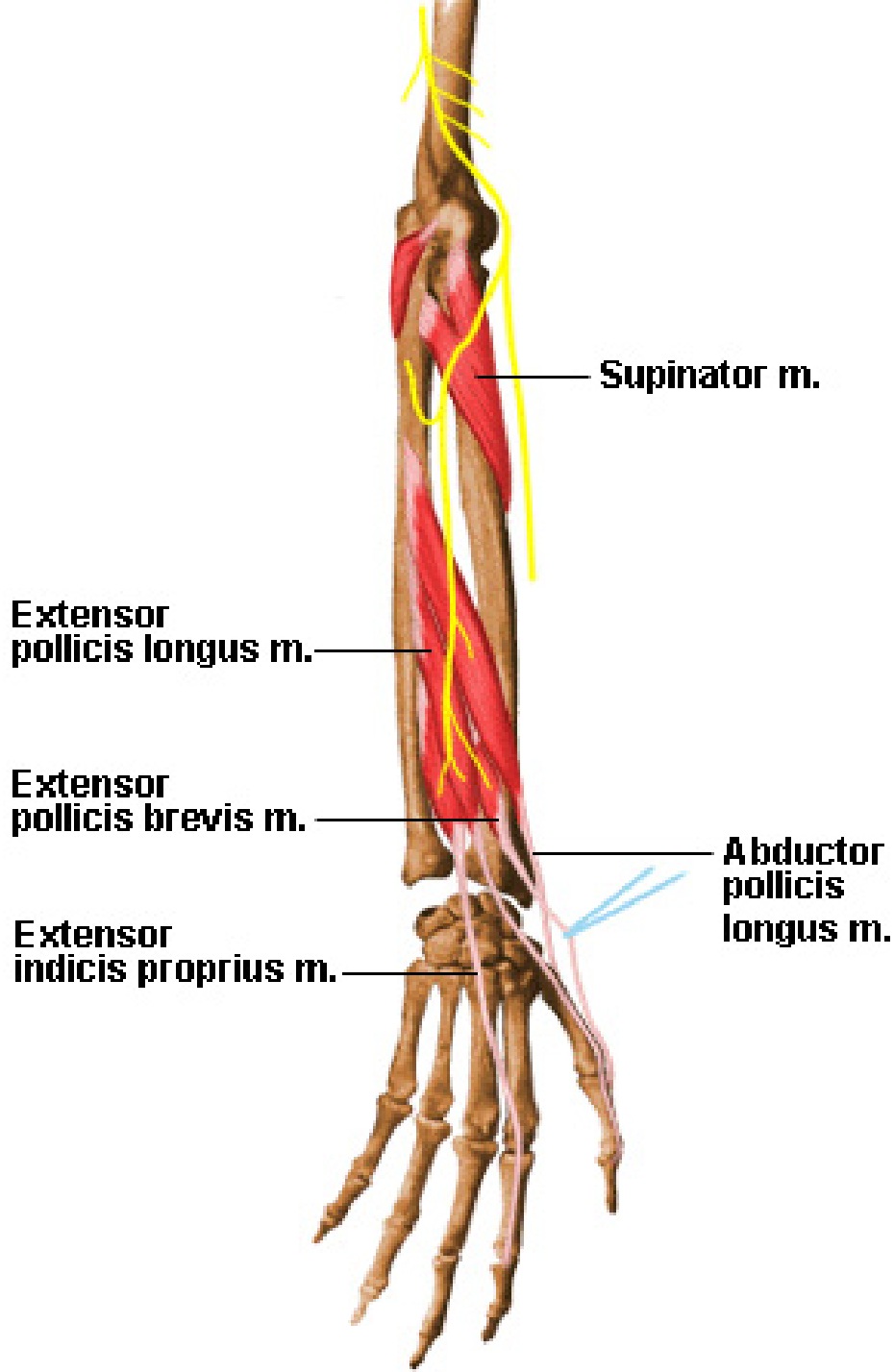
1 acromiodeltoideus
2 acromiotrapezius, cut
3 **anconeus**
4 **brachialis**
5 **brachioradialis**
6 clavobrachialis
7 clavotrapezius
8 **extensor carpi radialis longus**
9 **extensor carpi ulnaris**
10 **extensor digitorum**
11 **extensor digitorum lateralis**
12 **extensor indicis proprius**
13 **flexor carpi ulnaris**
14 **flexor digitorum profundus,** fifth head
15 infraspinatus
16 latissimus dorsi, cut
17 **levator scapulae ventralis**
18 middle subscapular nerve and artery
19 pectoralis major, cut
20 radial nerve, superficial branch
21 rhomboideus
22 serratus ventralis
23 spinodeltoideus, cut
24 spinotrapezius
25 supraspinatus
26 **teres major**
27 **teres minor**
28 **triceps brachii, lateral head,** cut
29 **triceps brachii, long head**
30 **triceps brachii, medial head, long portion**
31 **triceps brachii, medial head, interme-**

Radial Nerve (cont)

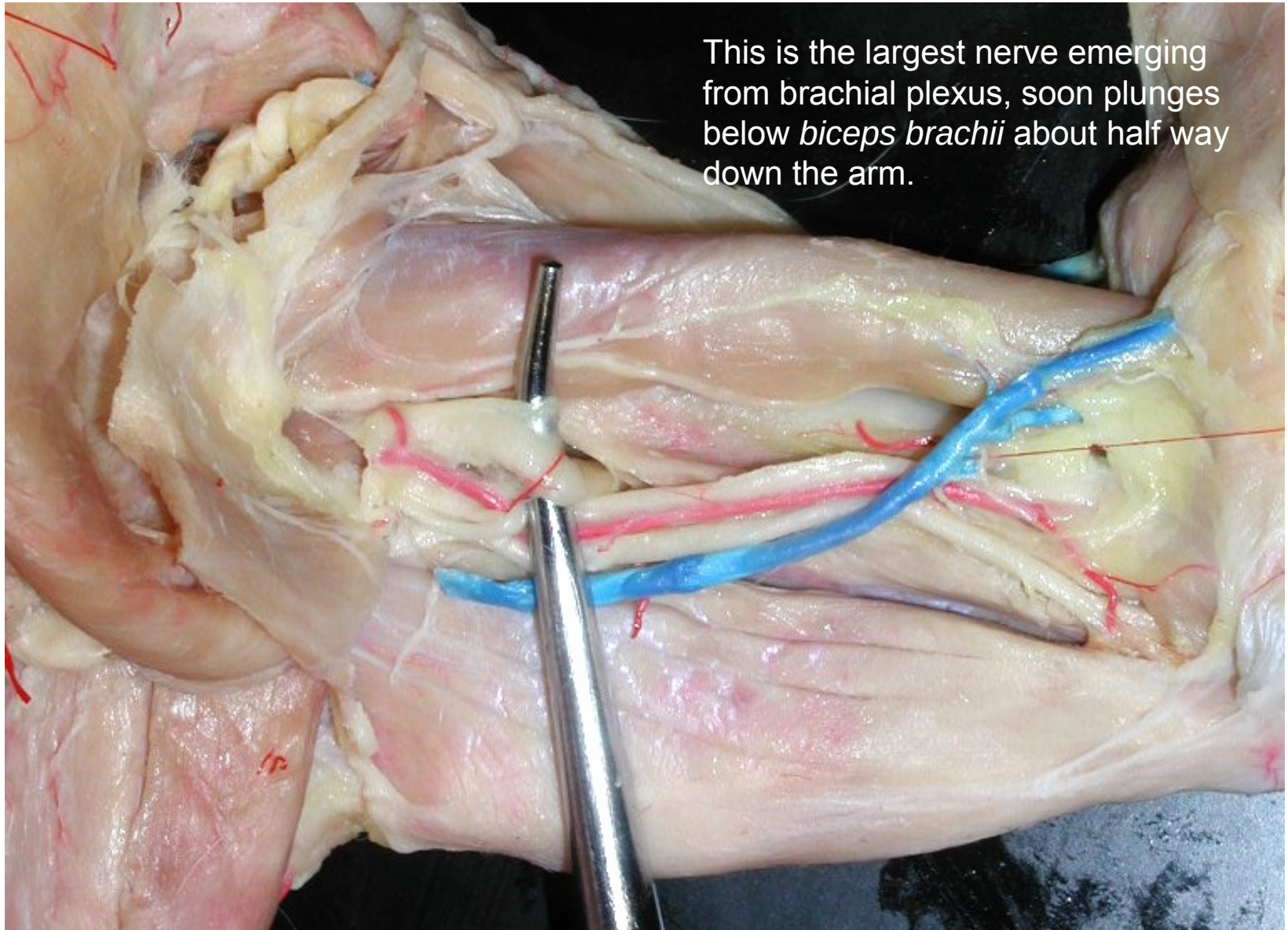
- the **posterior interossous nerve**, which sequentially supplies motor innervation to the
- **supinator**
- **extensor digitorum,**
- **extensor digiti minimi,**
- **extensor carpi ulnaris,**
- **abductor pollicis longus,**
- **extensor pollicis longus,**
- **extensor pollicis brevis**
- **extensor indicis proprius**

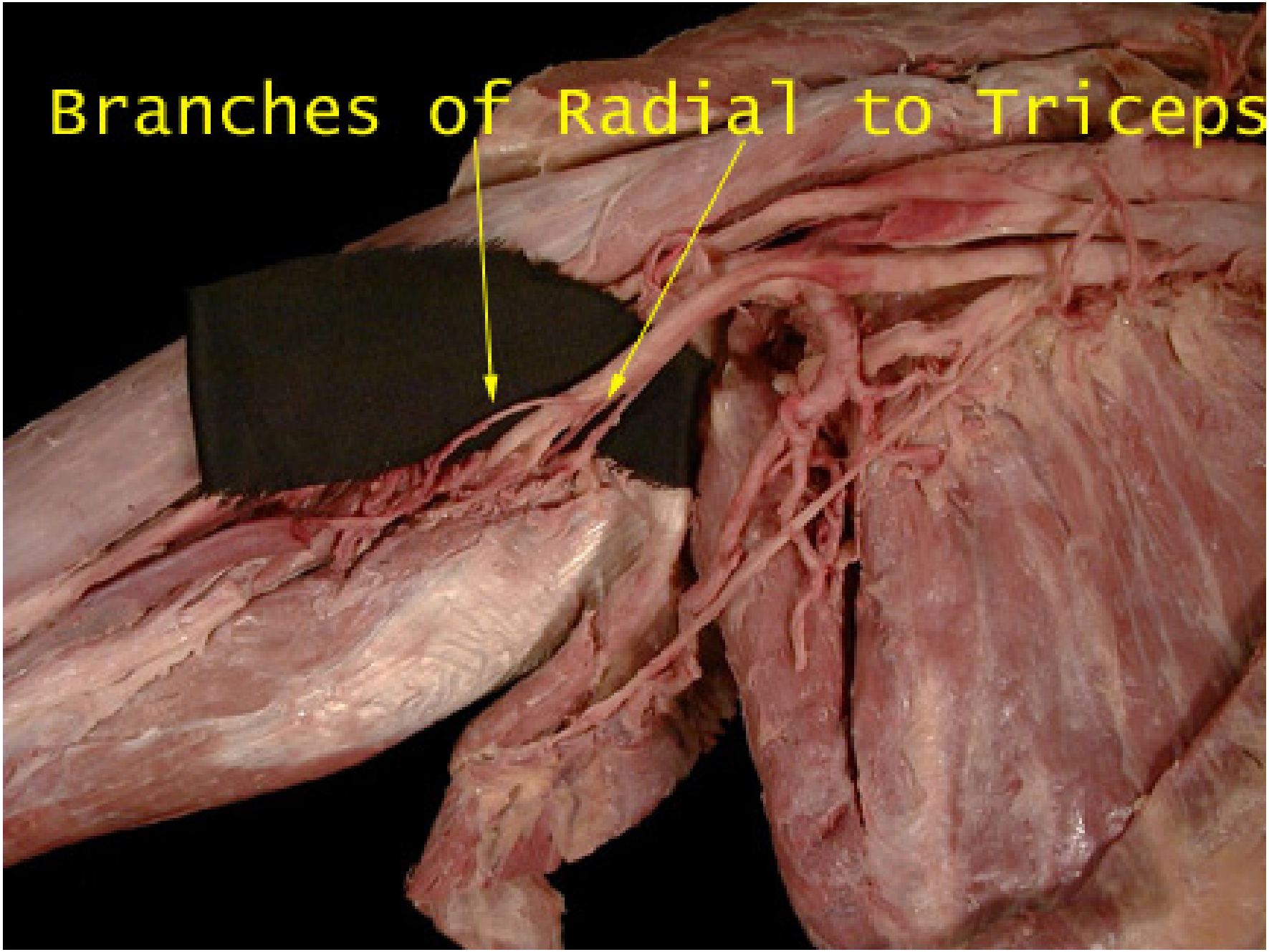

Radial Nerve in Forearm
(C5, 6, 7, 8; T1)
(viewed from behind and slightly laterally)
Radial nerve
Superficial branch
Deep terminal branch
Lateral epicondyle
Anconeus m.
Brachioradialis m.
Extensor carpi radialis longus m.
Supinator m.
Extensor carpi radialis brevis m.
Extensor carpi ulnaris m.
Extensor digitorum m. and extensor digiti minimi m.
Extensor indicis m.
Extensor pollicis longus m.
Abductor pollicis longus m.
Extensor pollicis brevis m.
Extensor-supinator group of muscles
Posterior interosseous n.
(deep branch of radial n. distal to muscular branches)
Superficial branch of radial n.
Dorsal digital nn.
From axillary nerve
Superior lateral brachial cutaneous n.
From radial nerve
Inferior lateral brachial cutaneous n.
Posterior brachial cutaneous n.
Posterior antebrachial cutaneous n.
Superficial branch of radial n.
Cutaneous innervation from radial and axillary nerves

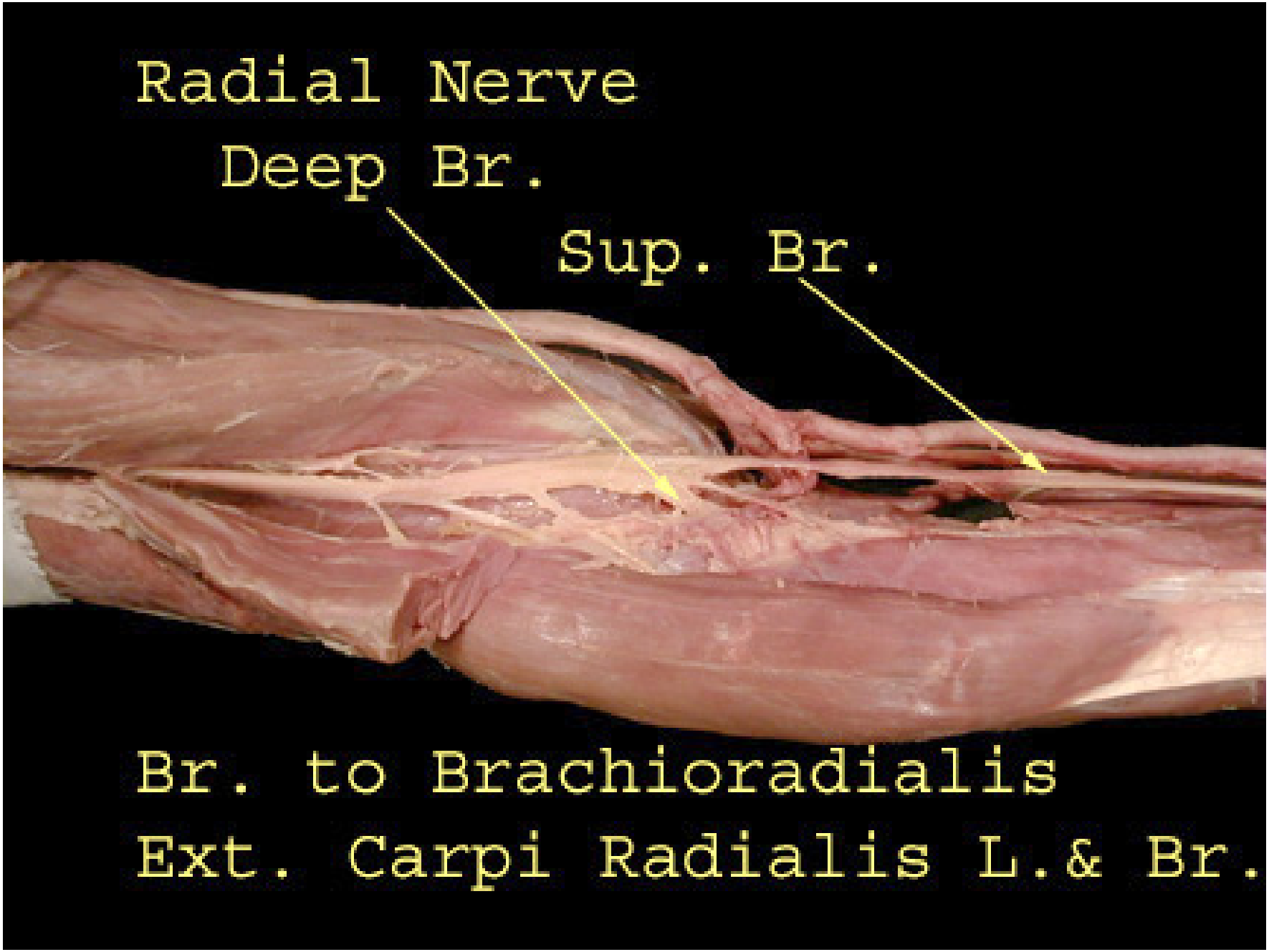
Radial Nerve

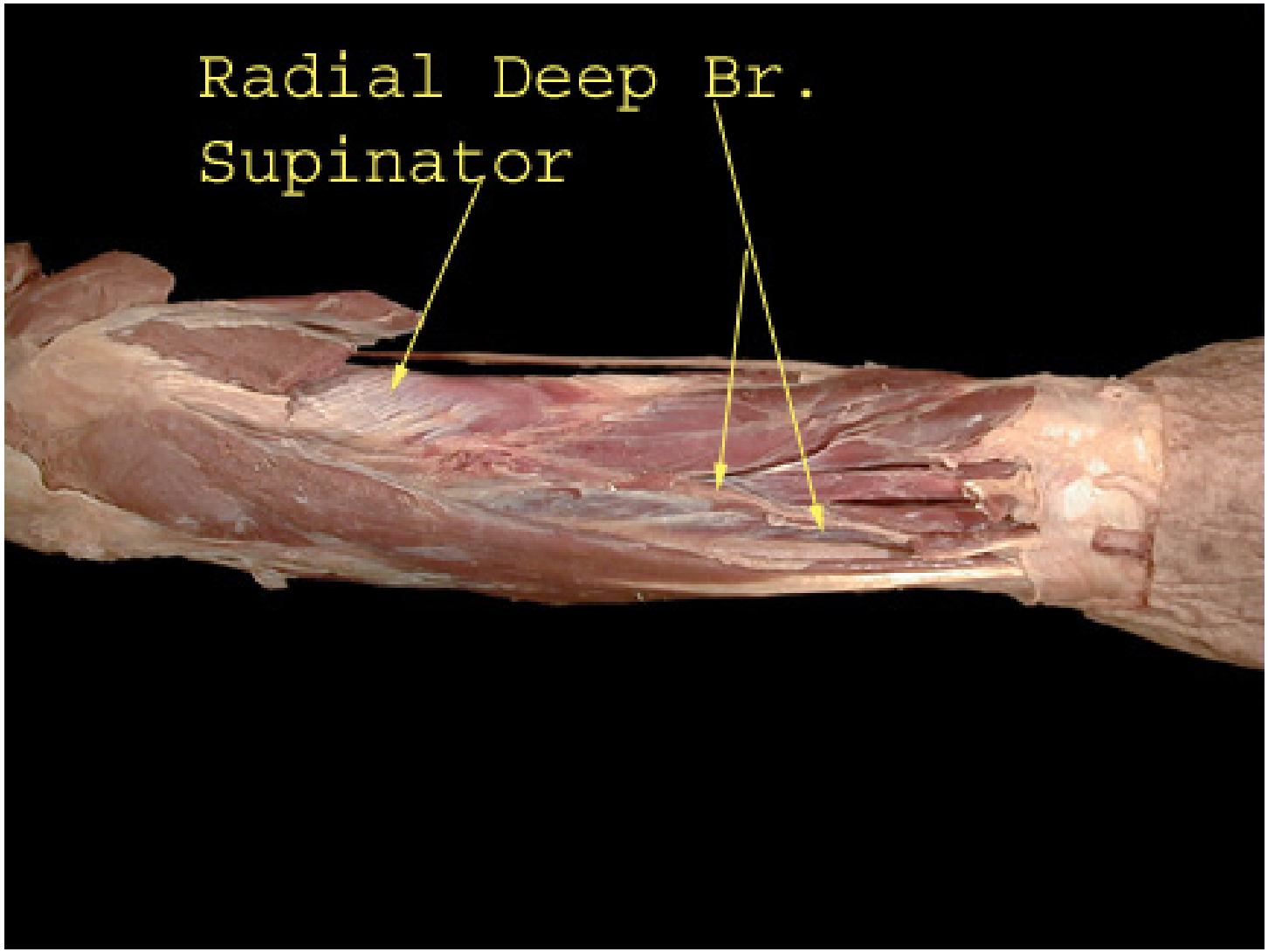


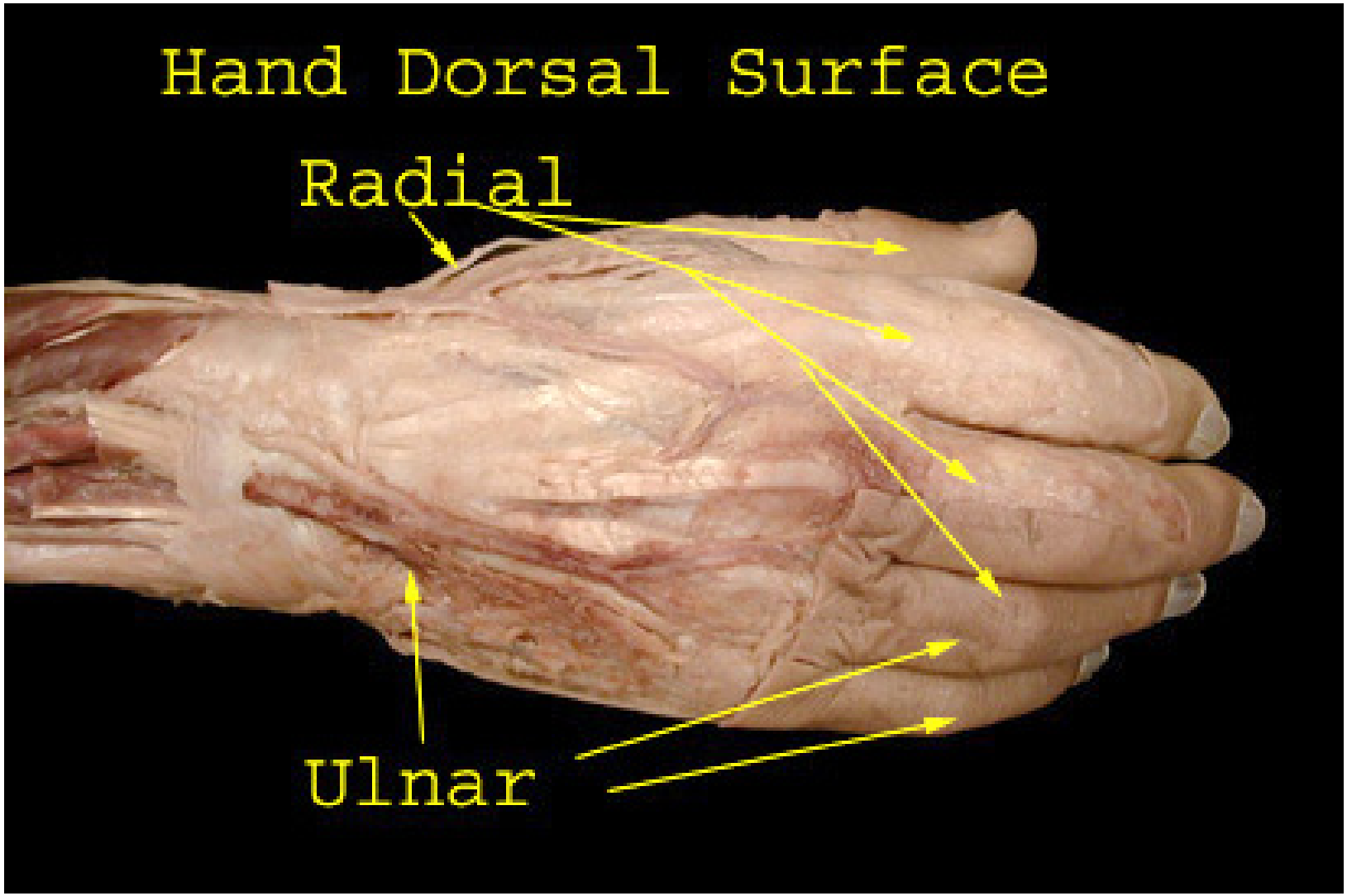
Radial Nerve: Cat

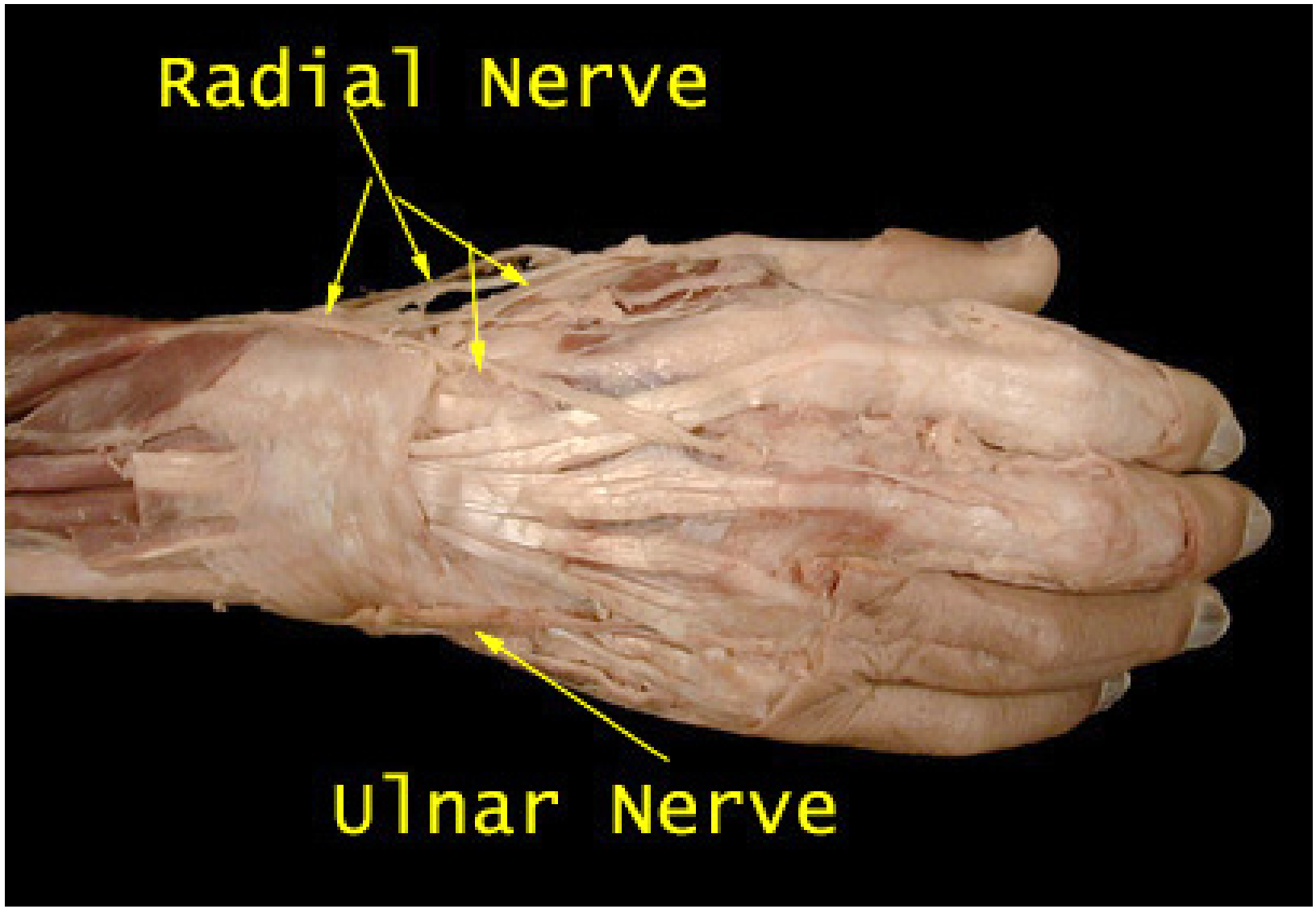


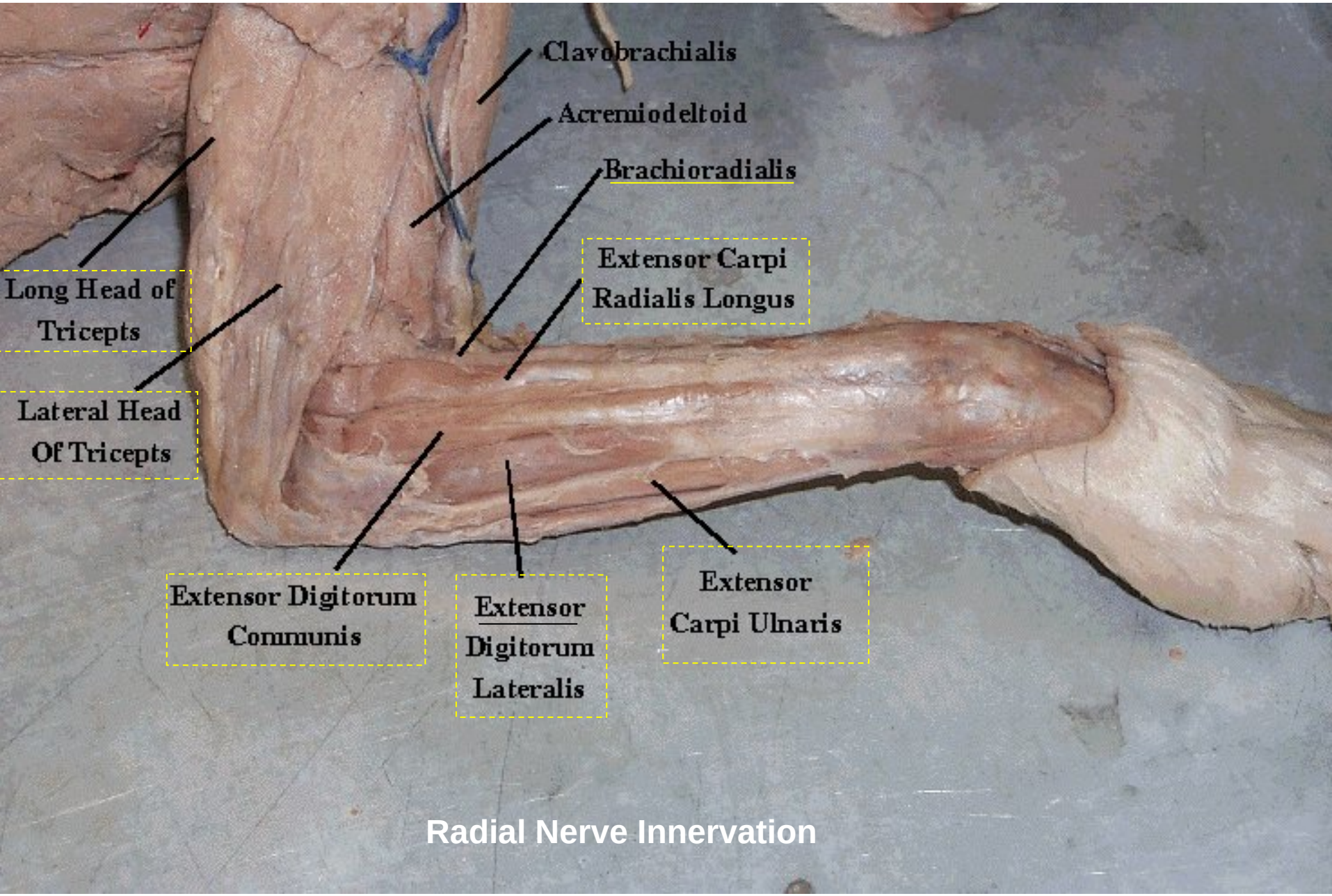

Branches of Radial to Triceps


Radial Nerve
Deep Br.
Sup. Br.
Br. to Brachioradialis
Ext. Carpi Radialis L.& Br.

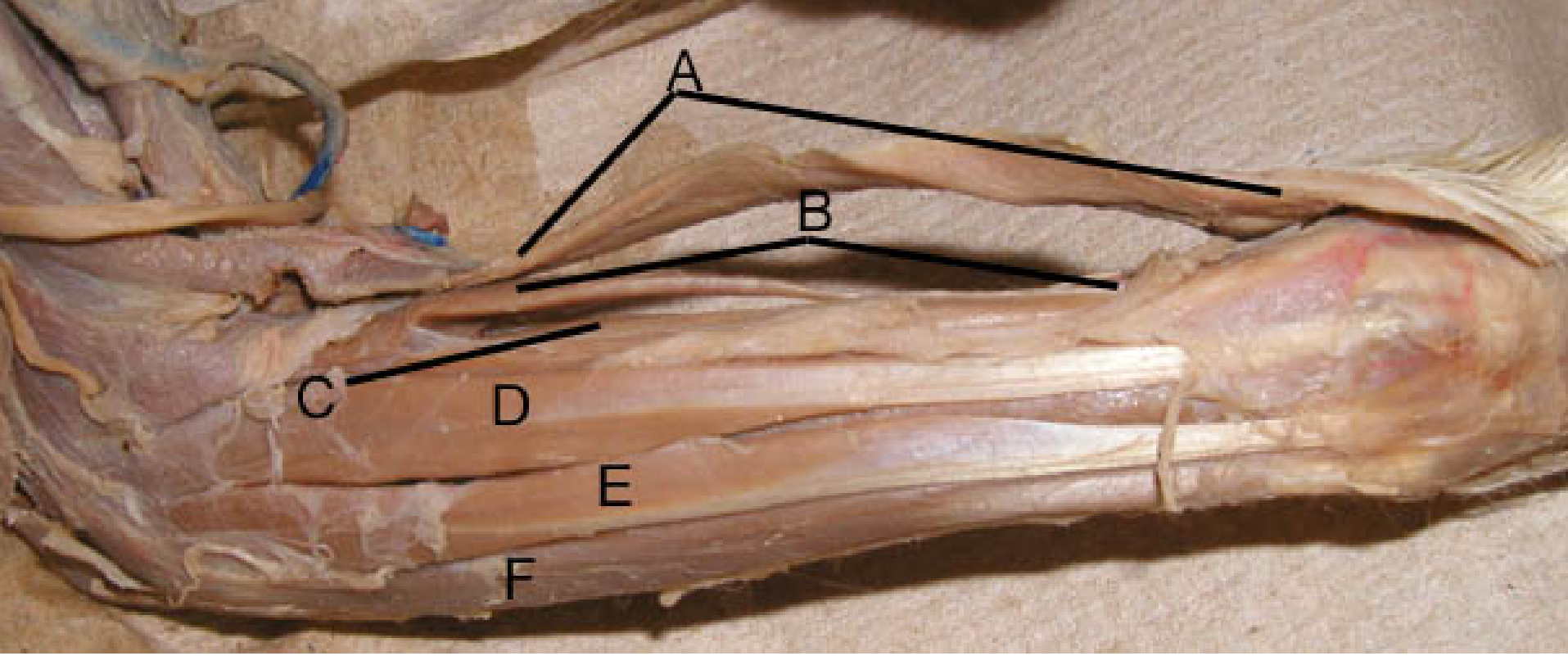

Radial Deep Br.
Supinator


Hand Dorsal Surface
Radial
Ulnar

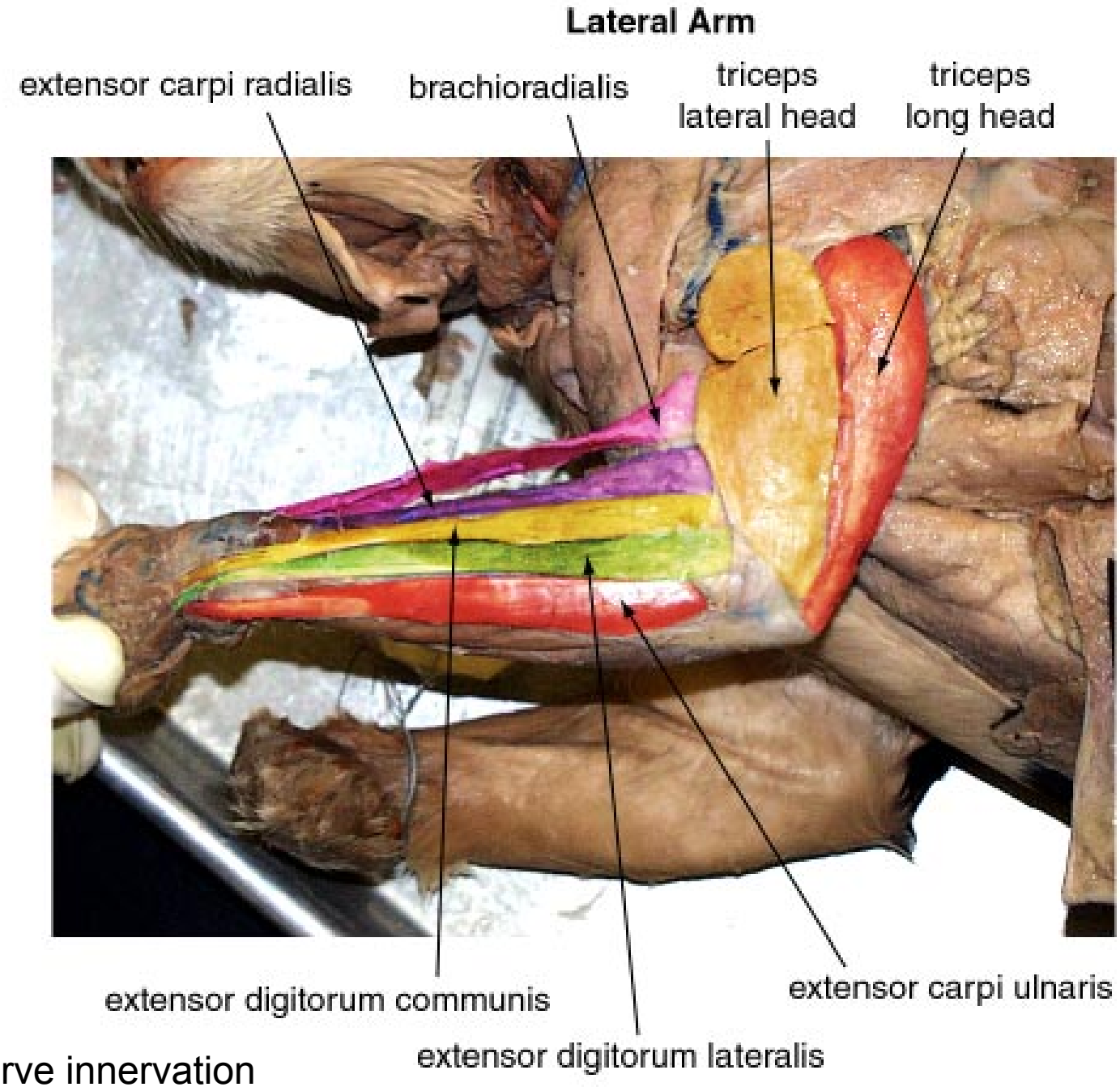

Radial Nerve
Ulnar Nerve



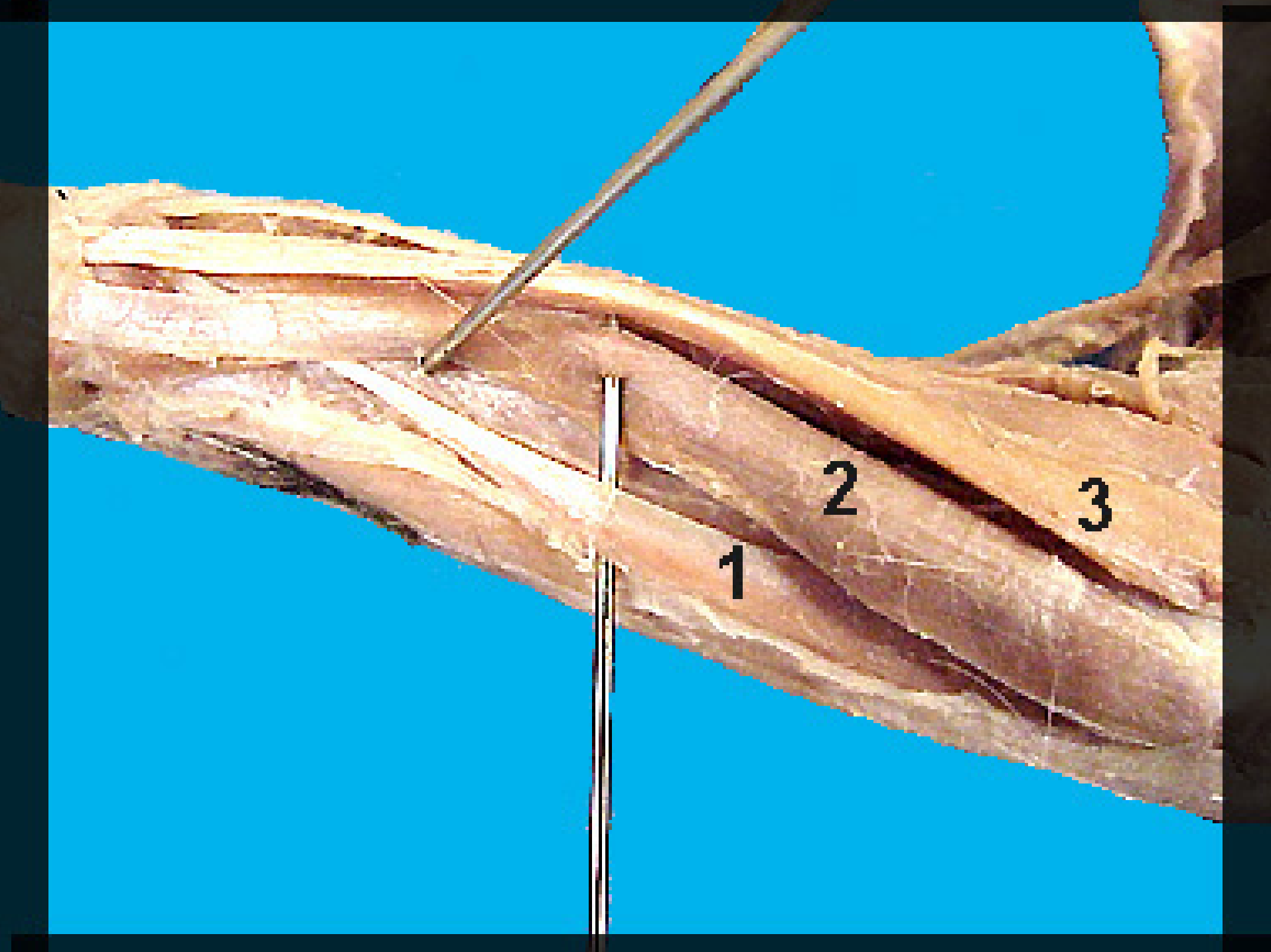
Radial Nerve Innervation



A – ***Brachioradialis*** **D** - ***Extensor digitorum communis*** **B** - ***Extensor carpi radialis longus*** (note the long white tendon) **E** - ***Extensor digitorum lateralis*** **C** - ***Extensor carpi radialis brevis*** (the body of this muscle is larger than the extensor carpi radialis longus) **F** - ***Extensor carpi ulnaris***

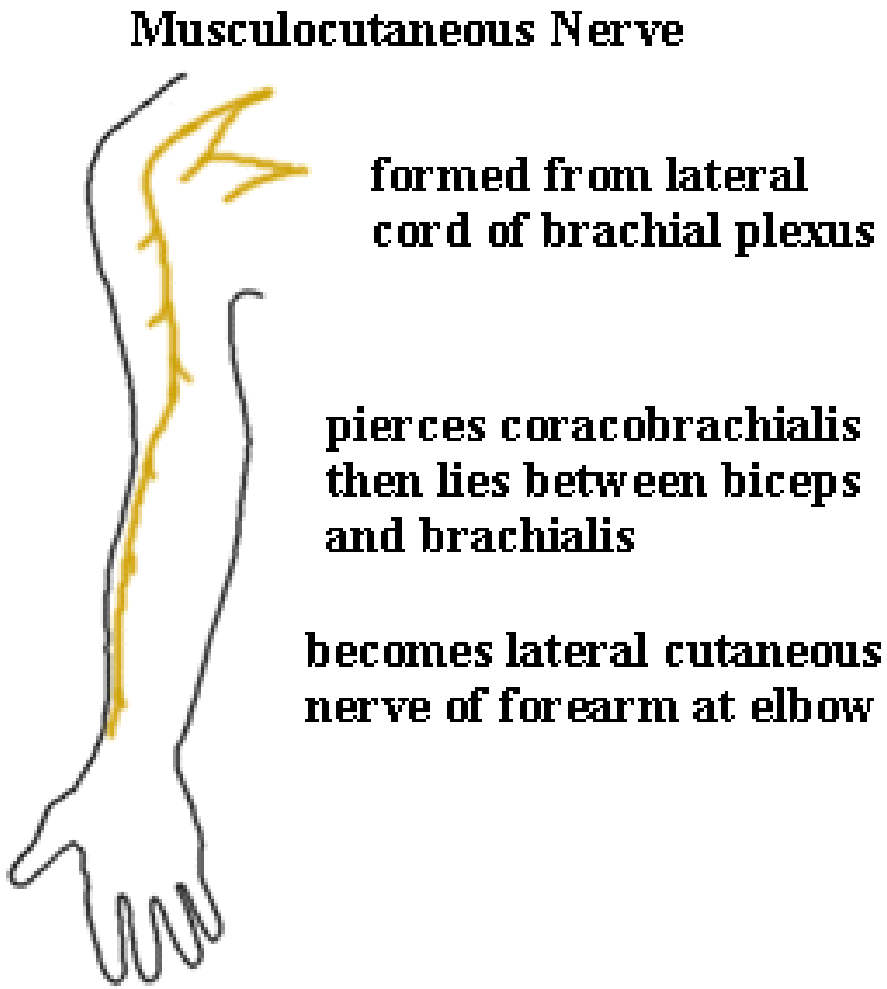


Radial nerve innervation

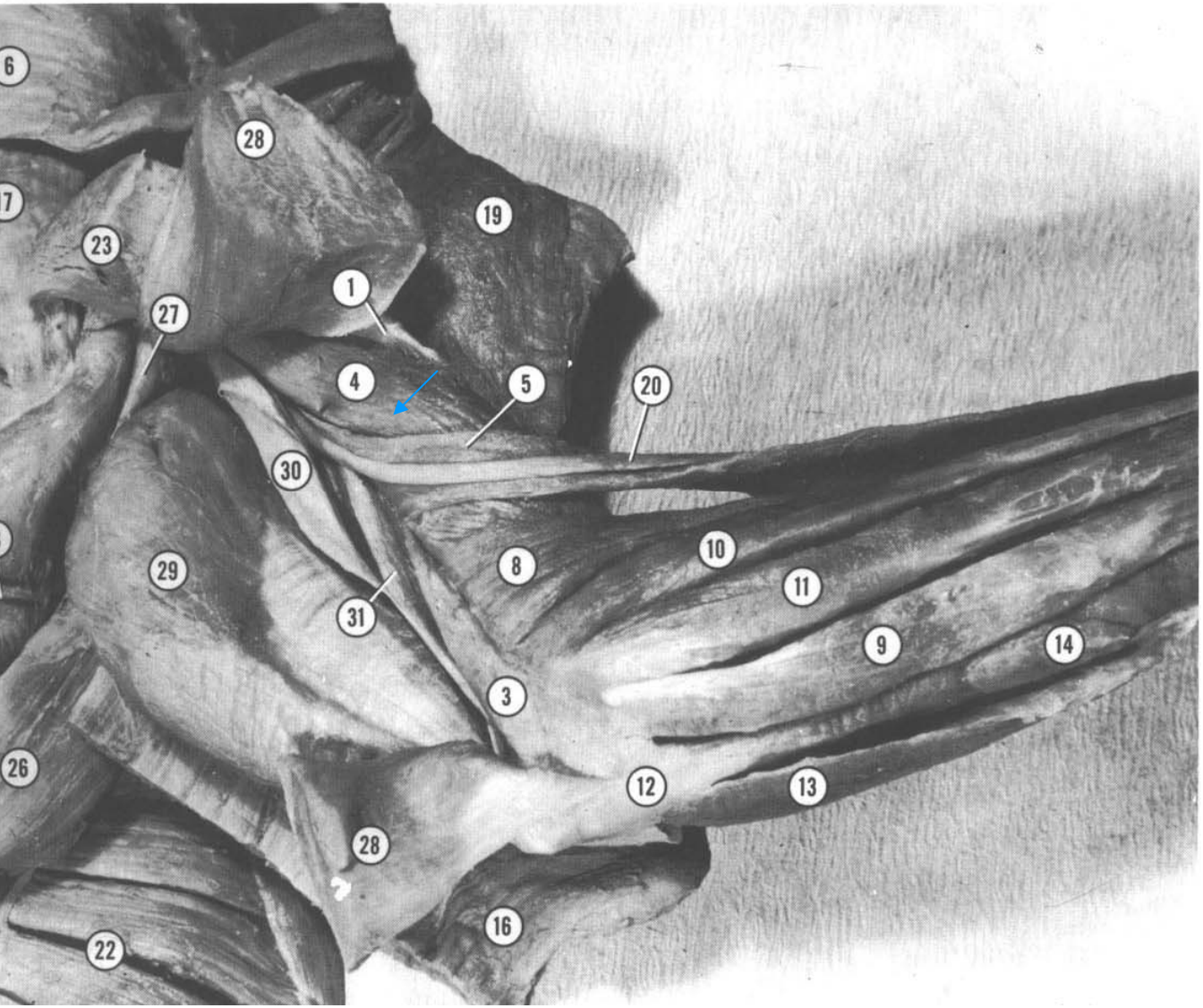

1
2
3

Musculocutaneous Nerve

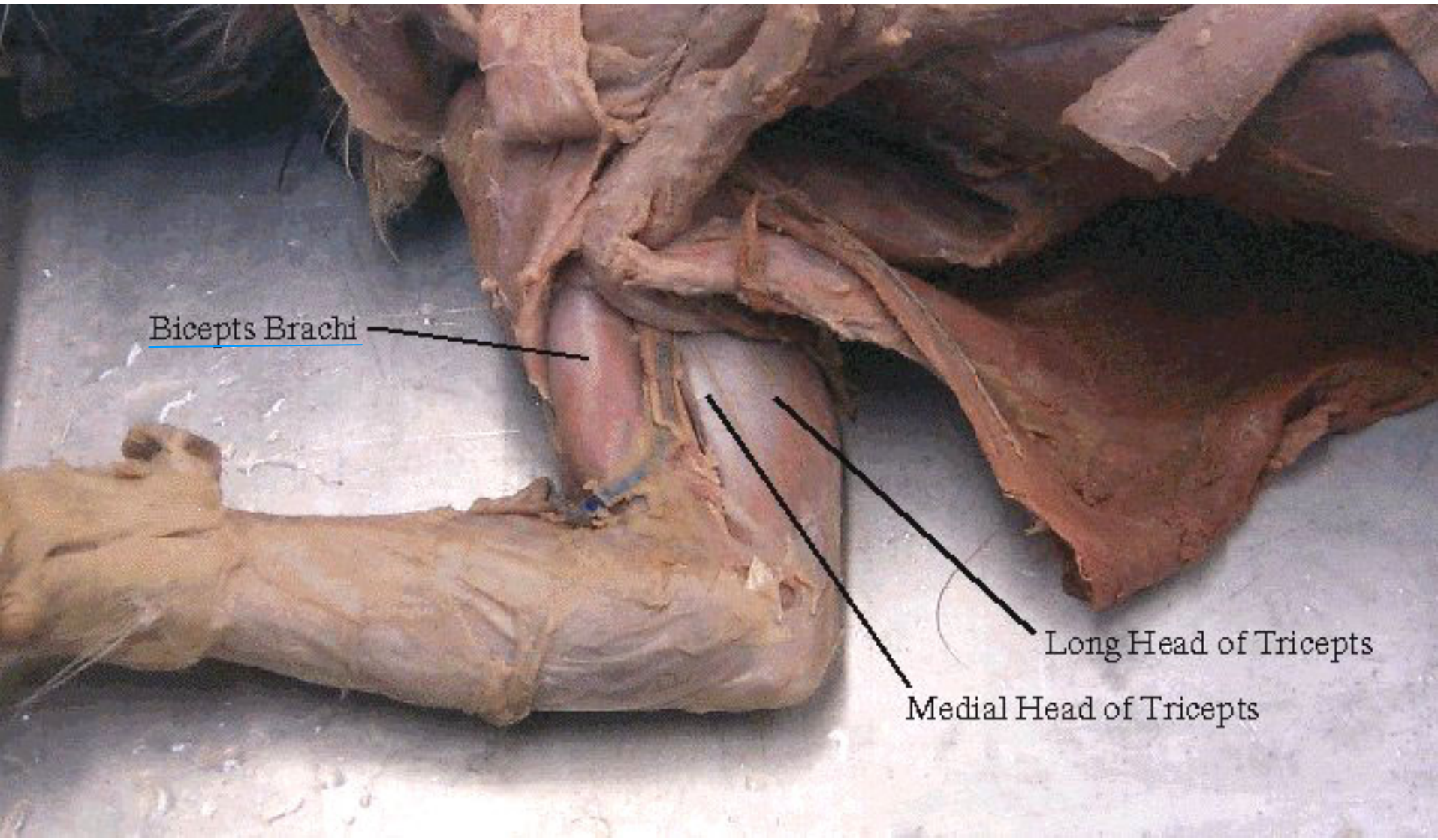
- The musculocutaneous nerve is formed from the **lateral cord** and contains the C5,6,7 nerve roots.
- The nerve enters the **coracobrachialis muscle** and passes through it to lie laterally between the **biceps and brachialis muscles.**
- The nerve **supplies all three muscles** and terminates as a **sensory nerve** which emerges from the lateral side of the tendon of biceps to **form the lateral cutaneous nerve** of the forearm.

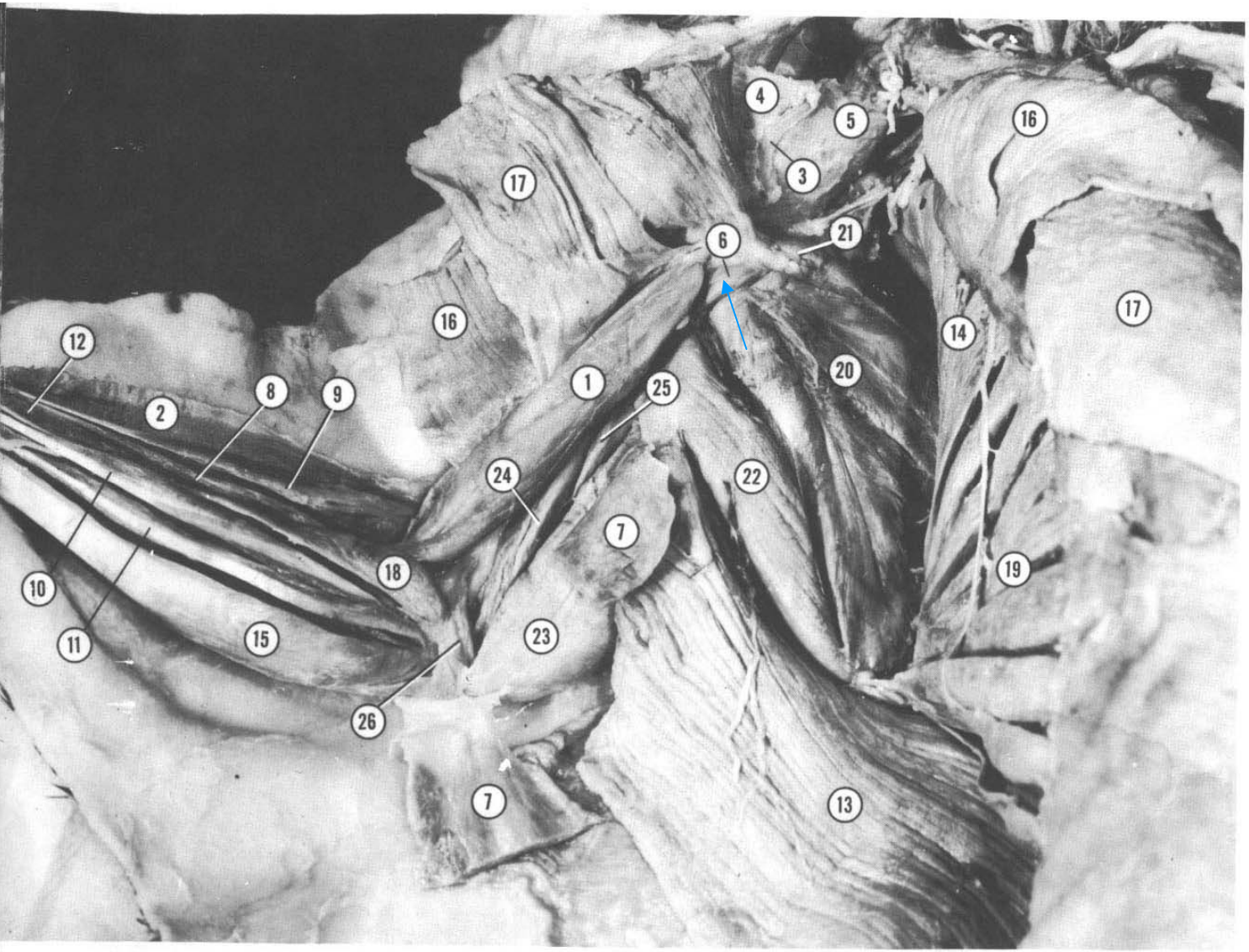

Musculocutaneous Nerve
formed from lateral cord of brachial plexus
pierces coracobrachialis then lies between biceps and brachialis
becomes lateral cutaneous nerve of forearm at elbow

Deep Muscles of the Forelimb, Later View



1 acromiodeltoideus
2 acromiotrapezius, cut
3 **anconeus**
4 **brachialis**
5 **brachioradialis**
6 clavobrachialis
7 clavotrapezius
8 **extensor carpi radialis longus**
9 **extensor carpi ulnaris**
10 **extensor digitorum**
11 **extensor digitorum lateralis**
12 **extensor indicis proprius**
13 **flexor carpi ulnaris**
14 **flexor digitorum profundus,** fifth head
15 infraspinatus
16 latissimus dorsi, cut
17 **levator scapulae ventralis**
18 middle subscapular nerve and artery
19 pectoralis major, cut
20 radial nerve, superficial branch
21 rhomboideus
22 serratus ventralis
23 spinodeltoideus, cut
24 spinotrapezius
25 supraspinatus
26 **teres major**
27 **teres minor**
28 **triceps brachii, lateral head,** cut
29 **triceps brachii, long head**
30 **triceps brachii, medial head, long portion**
31 **triceps brachii, medial head, interme-**


Bicepts Brachi
Long Head of Tricepts
Medial Head of Tricepts



1 **biceps brachii**
2 brachioradialis
3 **clavicle**
4 clavobrachialis, cut
5 clavotrapezius
6 **coracobrachialis**
7 epitrochlearis, cut
8 **extensor carpi radialis brevis**
9 **extensor carpi radialis longus**
10 **flexor carpi radialis**
11 **flexor digitorum profundus, th**
12 **flexor digitorum profundus, fi**
13 latissimus dorsi
14 levator scapulae
15 palmaris longus
16 pectoralis major, cut
17 pectoralis minor, cut
18 **pronator teres**
19 serratus ventralis
20 subscapularis
21 supraspinatus
22 teres major
23 triceps brachii,long head
24 **triceps brachii, medial head, i diate portion**
25 **triceps brachii, medial head, lo tion**
26 **triceps brachii, medial head, sh tion**

Median Nerve

- Formed in the axilla by a branch from each of the lateral and medial cords.
- The two roots of the median nerve arise on either side of the axillary artery and fuse to form the median nerve anterior to the artery.
- midway down the arm it crosses anteriorly to lie medial to the artery.
- passes between the two heads of pronator teres to enter the forearm.
- it supplies **pronator teres**, **flexor carpi radialis, palmaris longus and flexor digitorum superficialis.**

formed from medial and lateral cords

No branches to arm

Passes into forearm between heads of pronator teres

Gives off palmar cutaneous branch

Passes into hand below flexor retinaculum

Median Nerve

•As the nerve passes through pronator teres it gives off the **anterior interosseous nerve** which runs along the interosseous membrane to supply the **flexor pollicis longus**, **pronator quadratus** and the lateral half of the **flexor digitorum profundus muscles**.

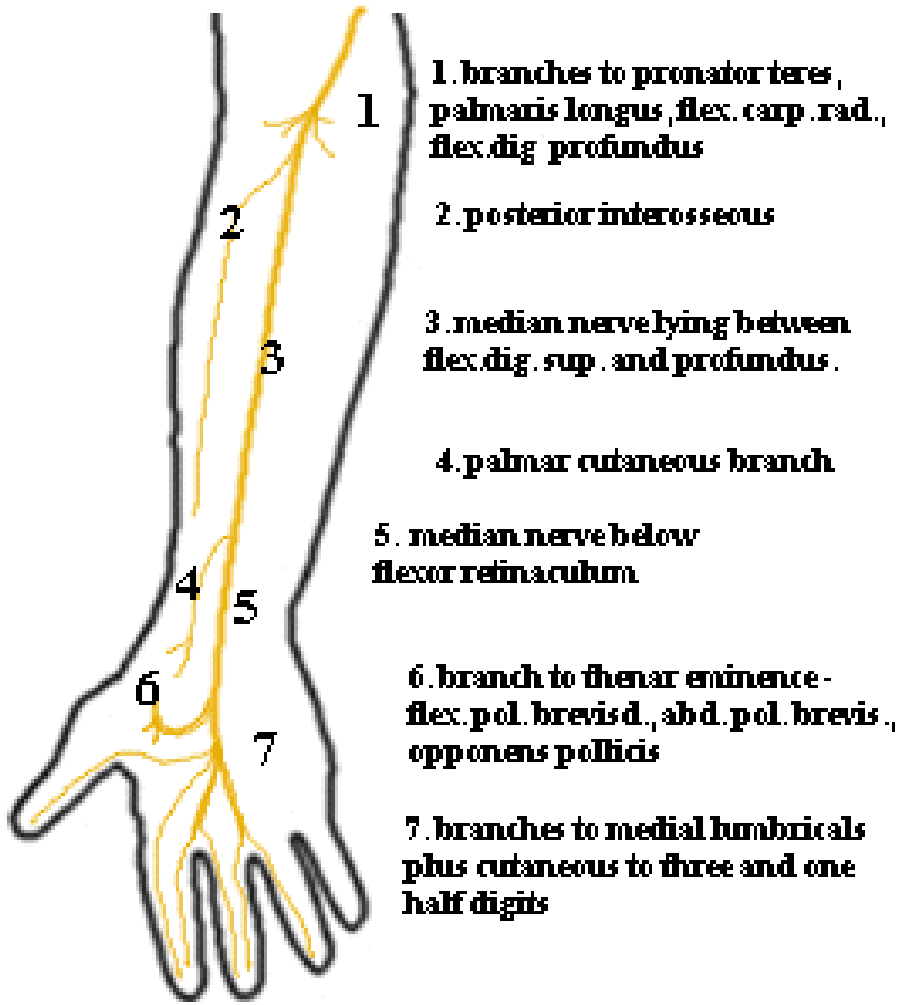
•continues on down the forearm attached to the underside of the flexor digitorum superficialis, and lying on the flexor digitorum profundus.

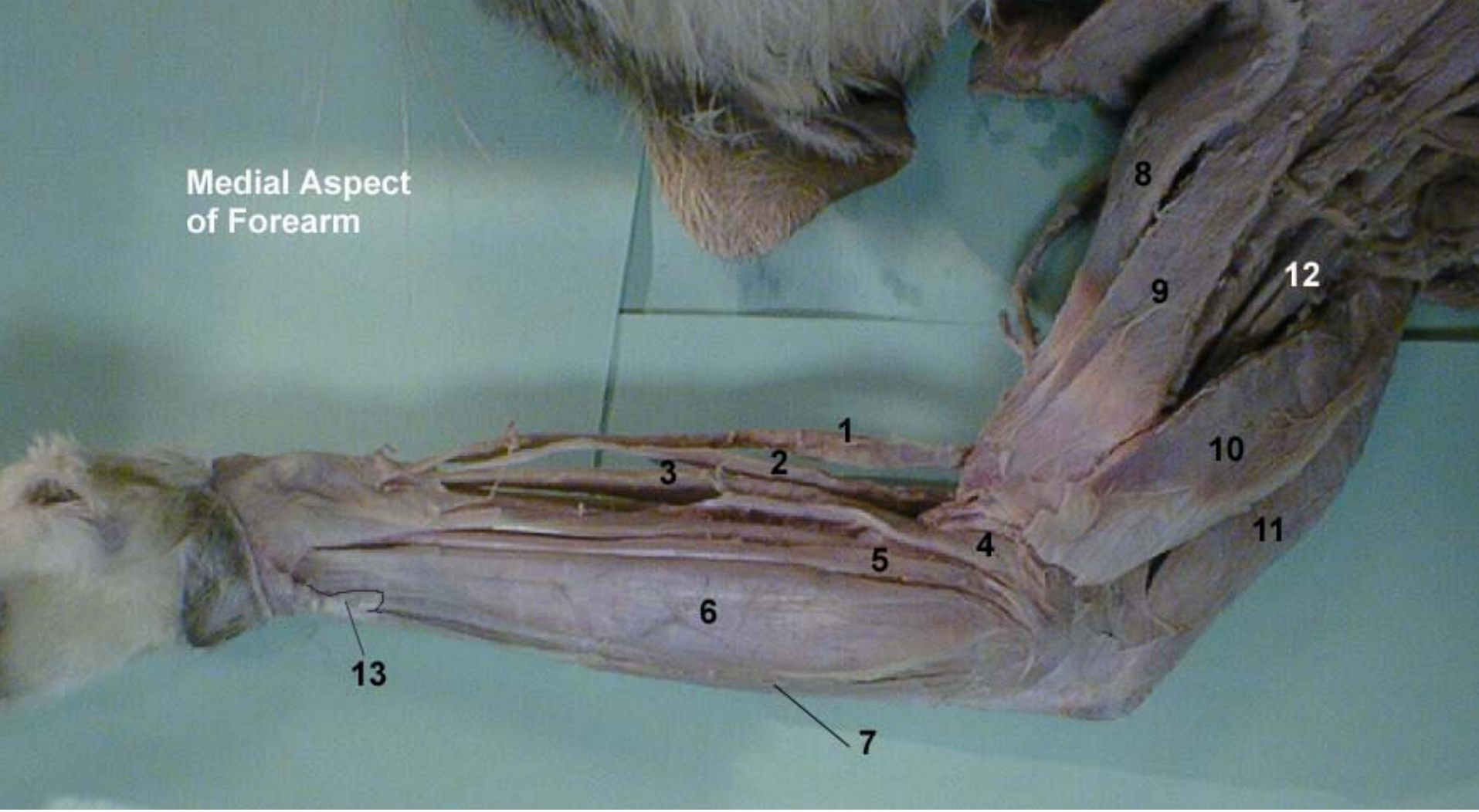
•gives off the **palmar cutaneous branch** which supplies the central part of the **palm** and the thenar eminence.

•continues through the carpal tunnel into the hand.

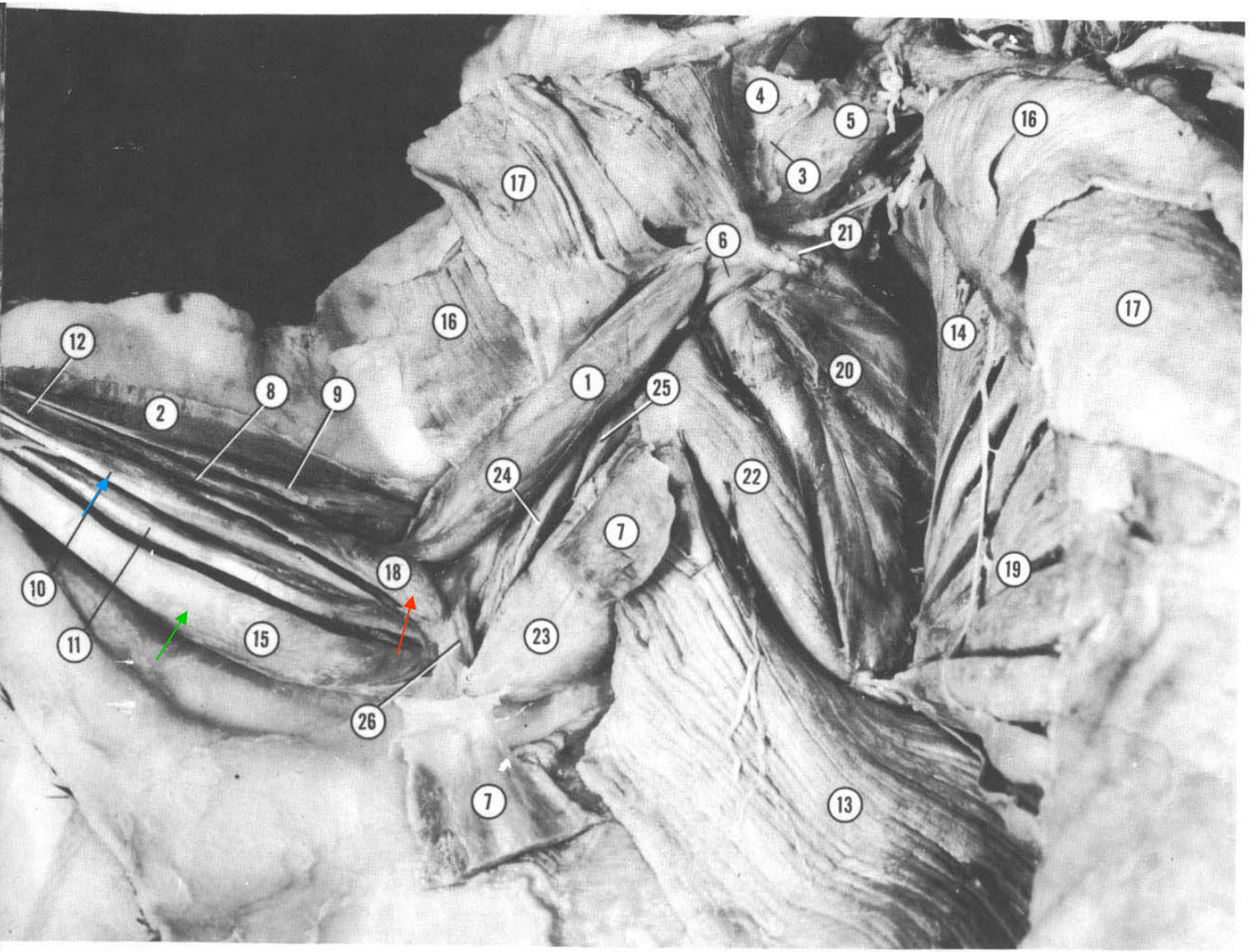
•In the hand the nerve forms a

- •**muscular branch** and the- supply the muscles of the thenar eminence.
- •**palmar digital branches-** supply the palmar surface of the thumb, index and middle finger and the lateral half of the ring finger, and branches to the two lateral **lumbrical muscles**.

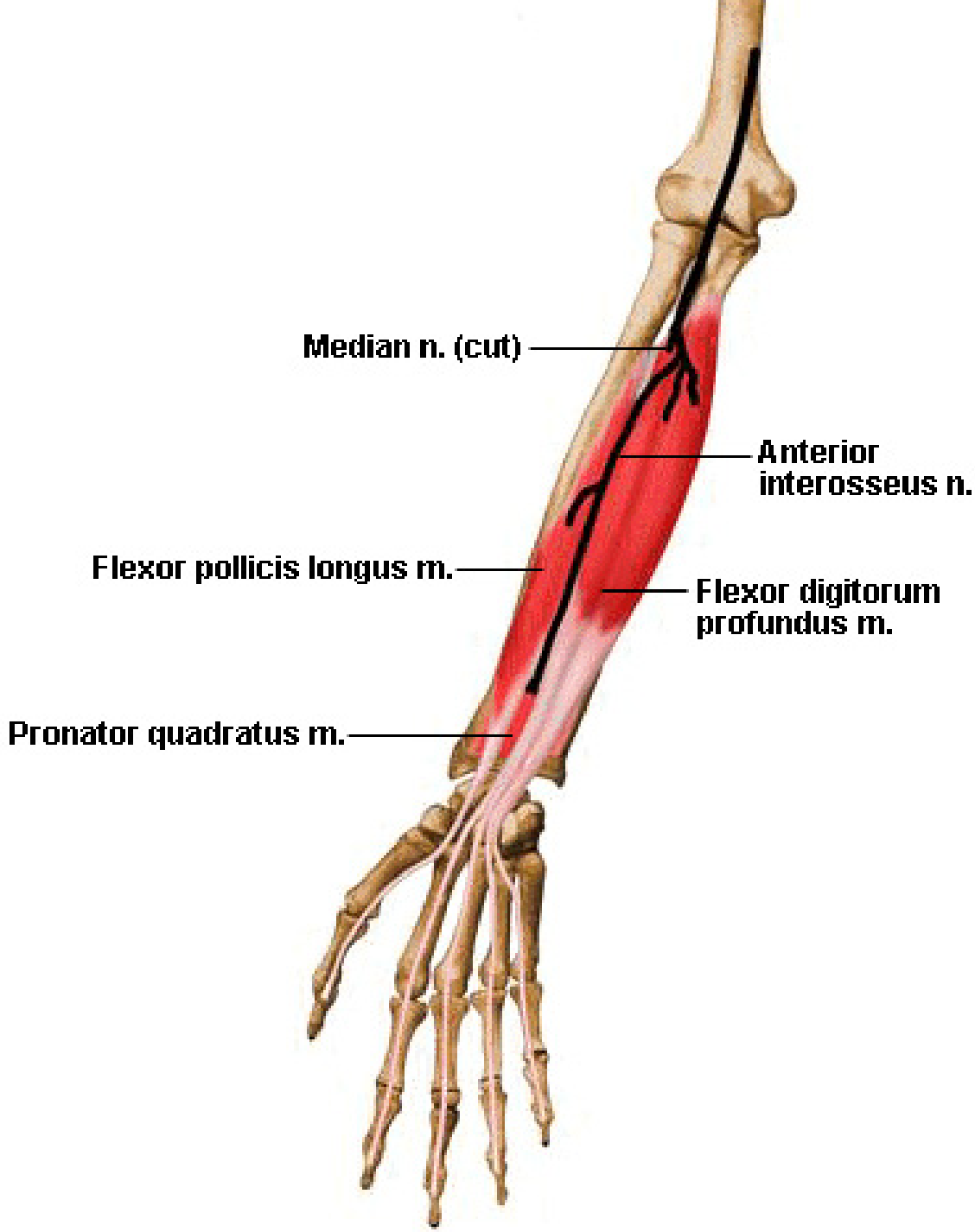

1
2
3
4
5
6
7
1. branches to pronator teres, palmaris longus, flex. carp. rad., flex dig profundus
2. posterior interosseous
3. median nerve lying between flex dig. sup. and profundus.
4. palmar cutaneous branch
5. median nerve below flexor retinaculum
6. branch to thenar eminence - flex. pol. brevis d., abd. pol. brevis., opponens pollicis
7. branches to medial lumbricals plus cutaneous to three and one half digits



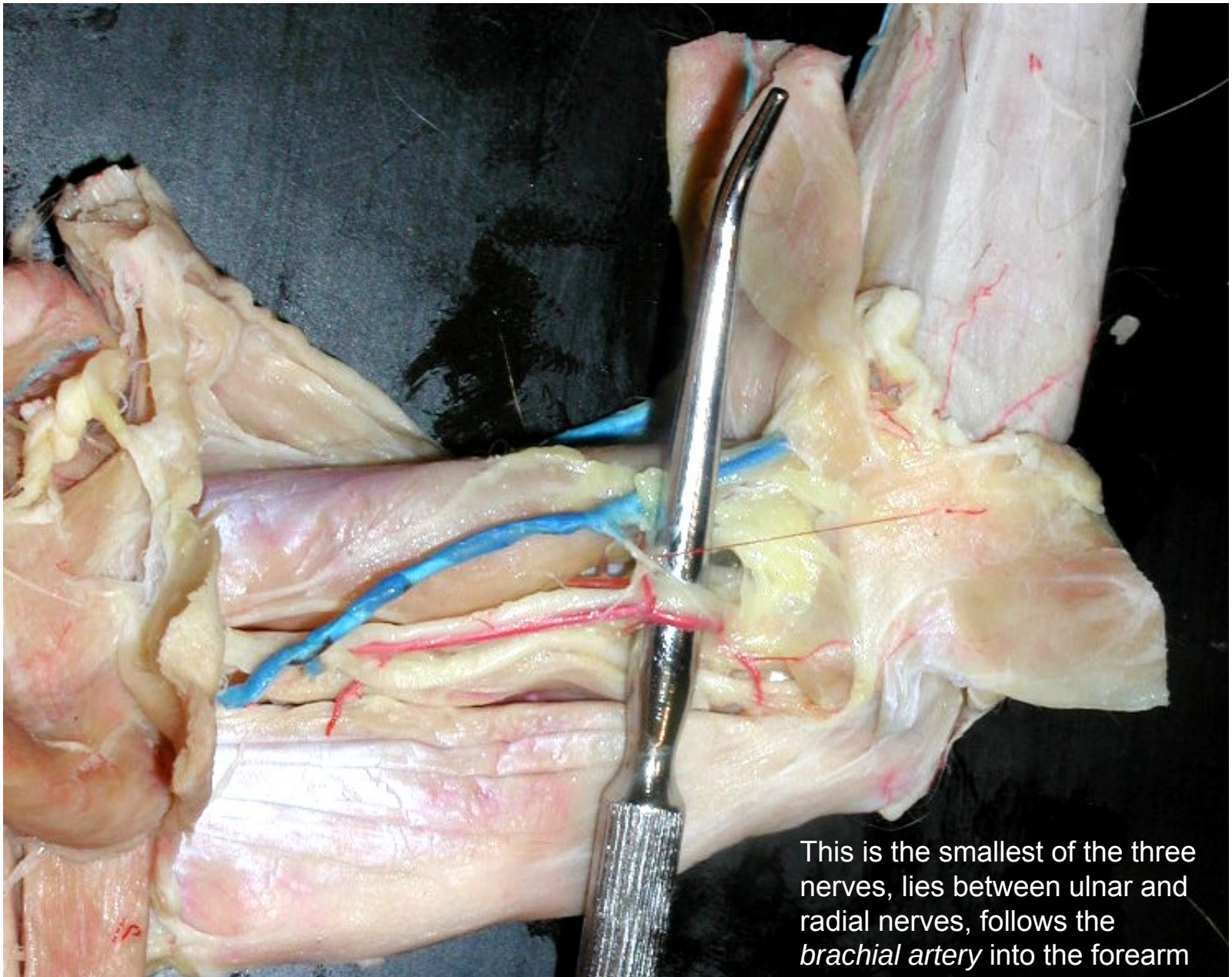
1.Brachioradialis, 2. Extensor Carpi Radialis Longus, 3. Extensor Carpi Radialis Brevis, **4. Pronator Teres**, **5.Flexor Carpi Radialis**, **6. Palmaris Longus**, 7. Flexor Carpi Ulnaris, 8.Clavodeltoid, 9.Biceps Brachii, 10.Epitrochlearis, 11.Long Head of Triceps, 12.Medial Head of Triceps, 13.Flexor Digitorum Superficialis



1 **biceps brachii**
2 brachioradialis
3 **clavicle**
4 clavobrachialis, cut
5 clavotrapezius
6 **coracobrachialis**
7 epitrochlearis, cut
8 **extensor carpi radialis brevis**
9 **extensor carpi radialis longus**
10 **flexor carpi radialis**
11 **flexor digitorum profundus, th**
12 **flexor digitorum profundus, fi**
13 latissimus dorsi
14 levator scapulae
15 palmaris longus
16 pectoralis major, cut
17 pectoralis minor, cut
18 **pronator teres**
19 serratus ventralis
20 subscapularis
21 supraspinatus
22 teres major
23 triceps brachii,long head
24 **triceps brachii, medial head, i diate portion**
25 **triceps brachii, medial head, lo tion**
26 **triceps brachii, medial head, sh tion**

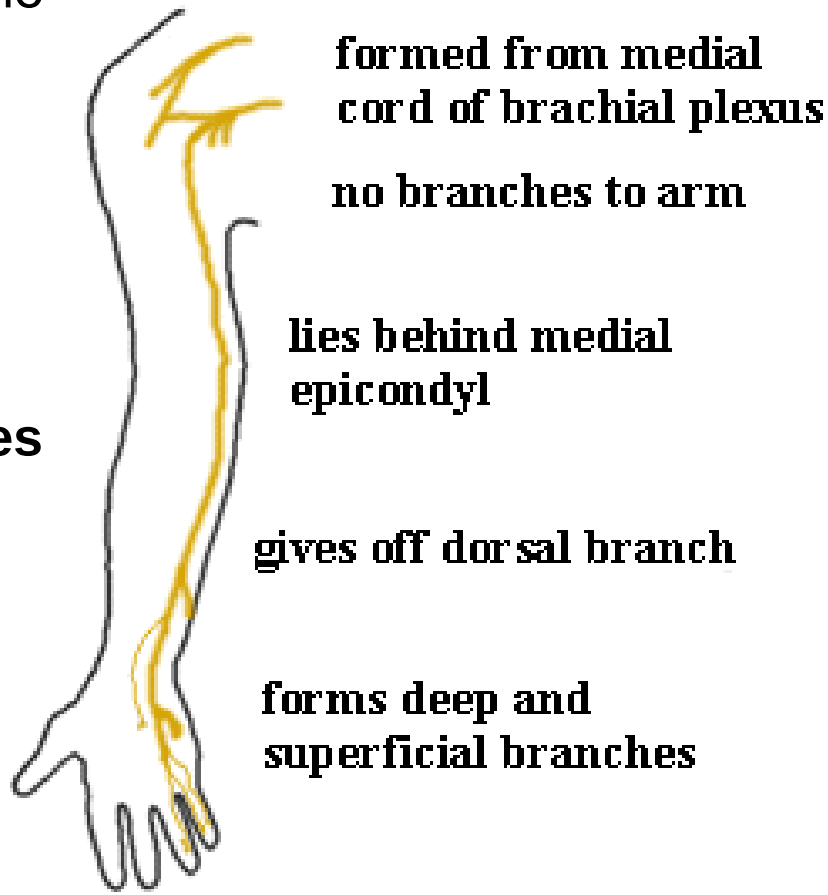

Median n. (cut)
Anterior interosseus n.
Flexor pollicis longus m.
Flexor digitorum profundus m.
Pronator quadratus m.

Median Nerve

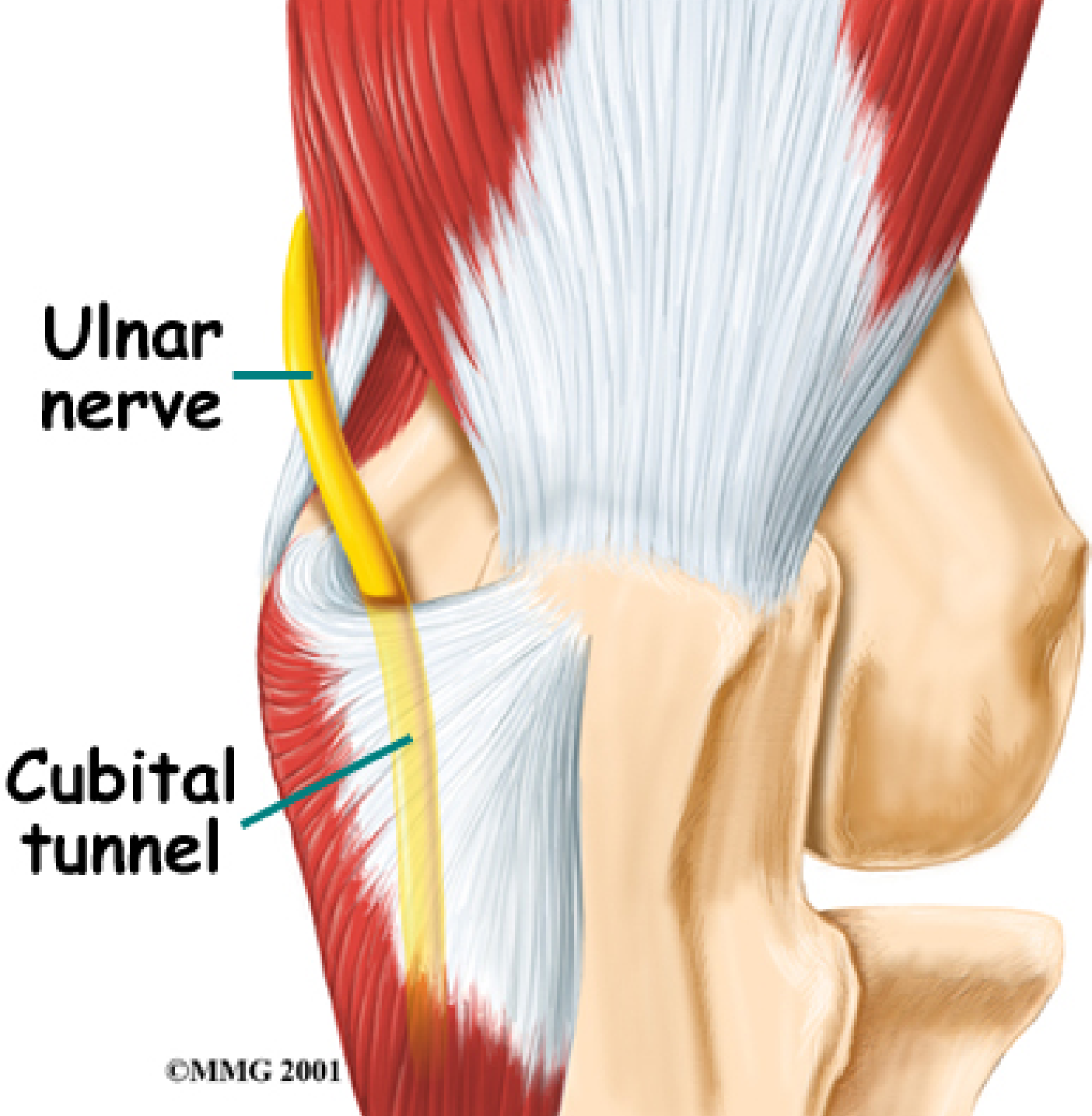

This is the smallest of the three nerves, lies between ulnar and radial nerves, follows the *brachial artery* into the forearm

Ulnar Nerve

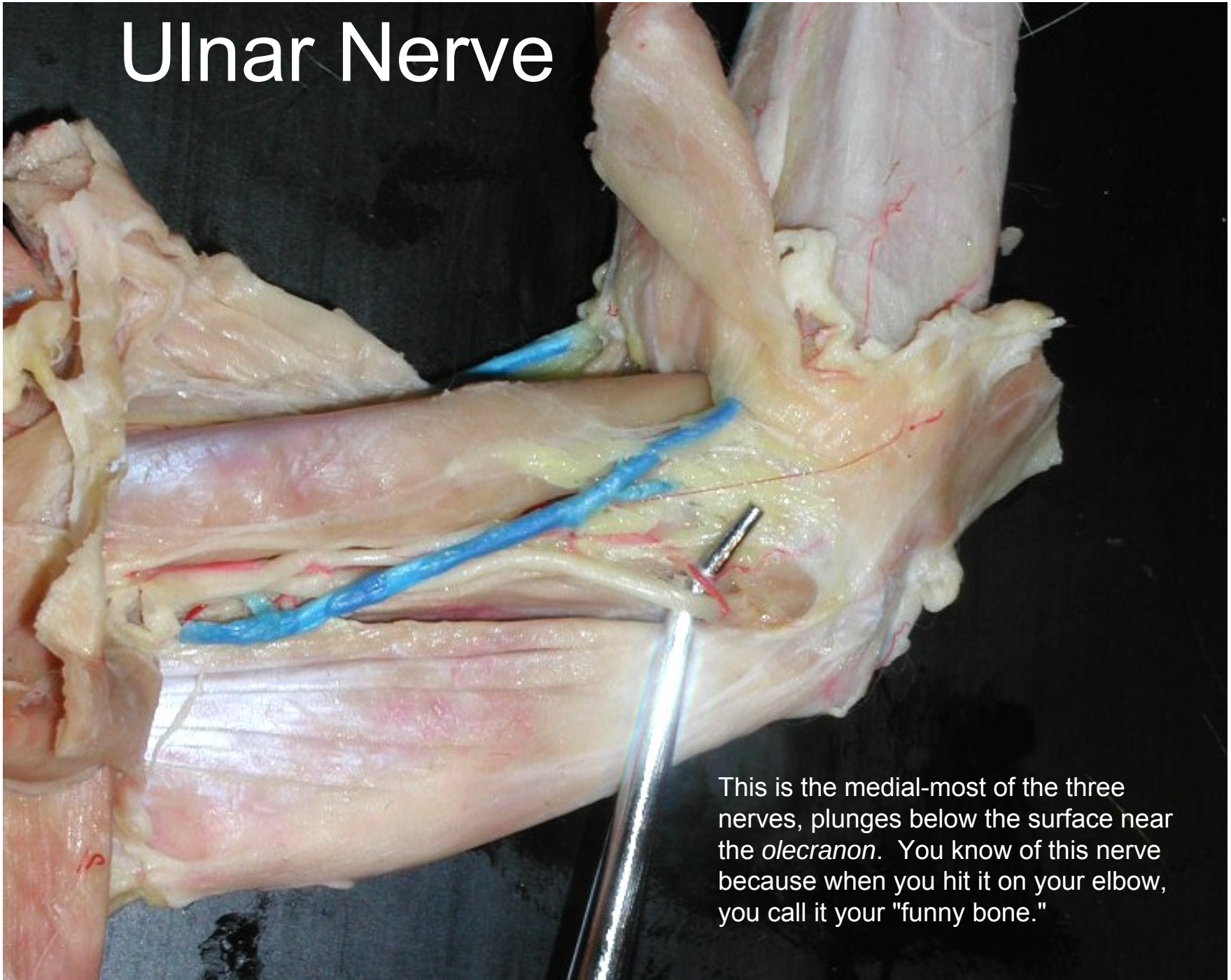
- Formed by fibres from the medial cord.
- Half way down the arm, it run between the medial epicondyle and the olecranon (cubital tunnel).
- It enters the forearm between the two heads of flexor carpi ulnaris.
- **In the upper forearm the nerve lies between the *flexor carpi ulnaris* muscles and the *flexor digitorum profundus* muscles,**


formed from medial cord of brachial plexus
no branches to arm
lies behind medial epicondyl
gives off dorsal branch
forms deep and superficial branches

next slide


Ulnar nerve
Cubital tunnel
©MMG 2001

Ulnar Nerve



This is the medial-most of the three nerves, plunges below the surface near the *olecranon*. You know of this nerve because when you hit it on your elbow, you call it your "funny bone."

•The ulnar nerve curls around behind the medial humeral epicondyle at the elbow and its first branches innervate the ***flexor carpi ulnaris*** and the ulnar half of the ***flexor digitorum profundus*** **(4th and 5th fingers)**

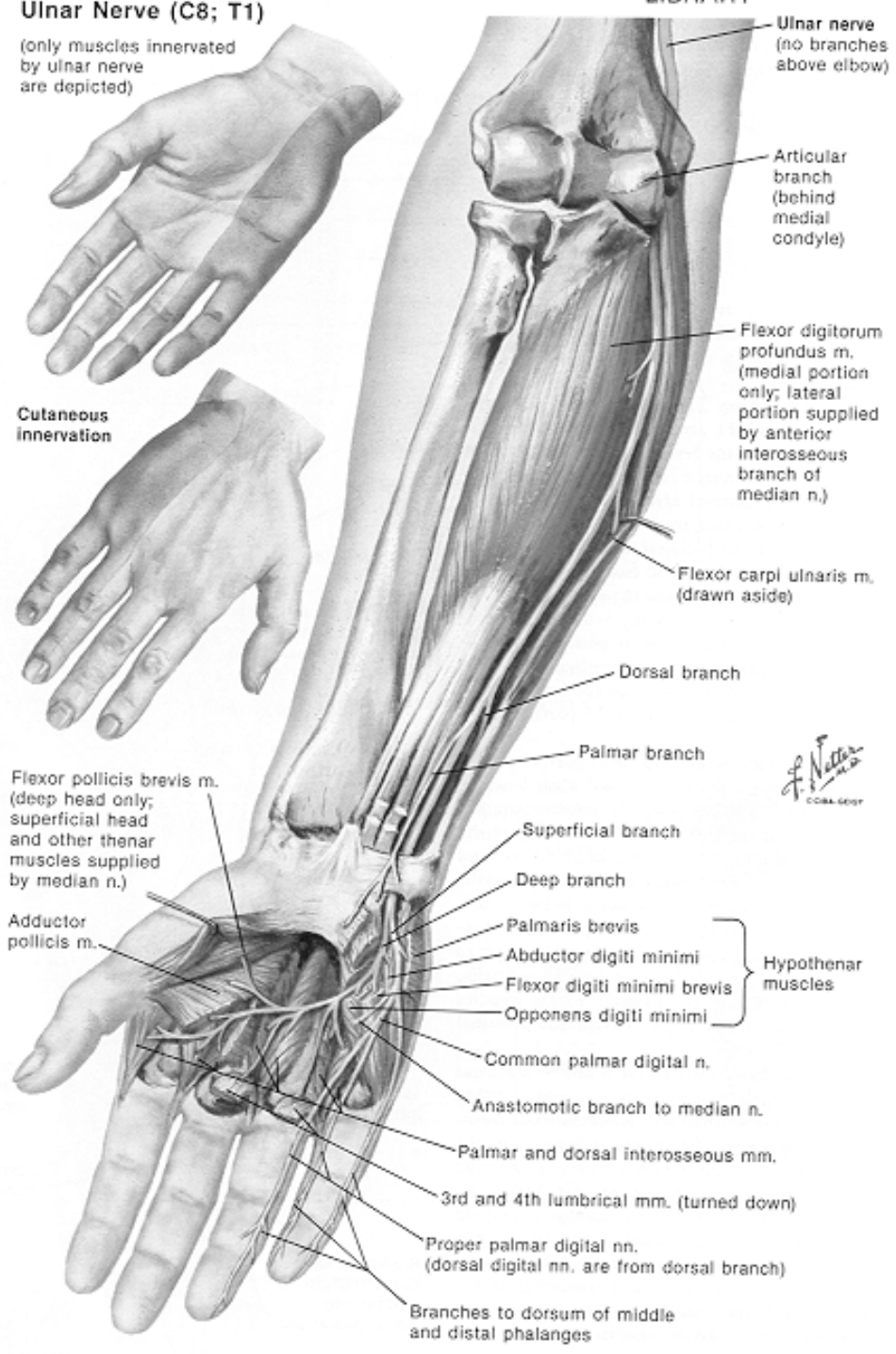
•courses down the forearm under the flexor carpi ulnaris muscle and continues to supply innervation to that muscle, but that it **does not innervate any other muscles in the forearm**

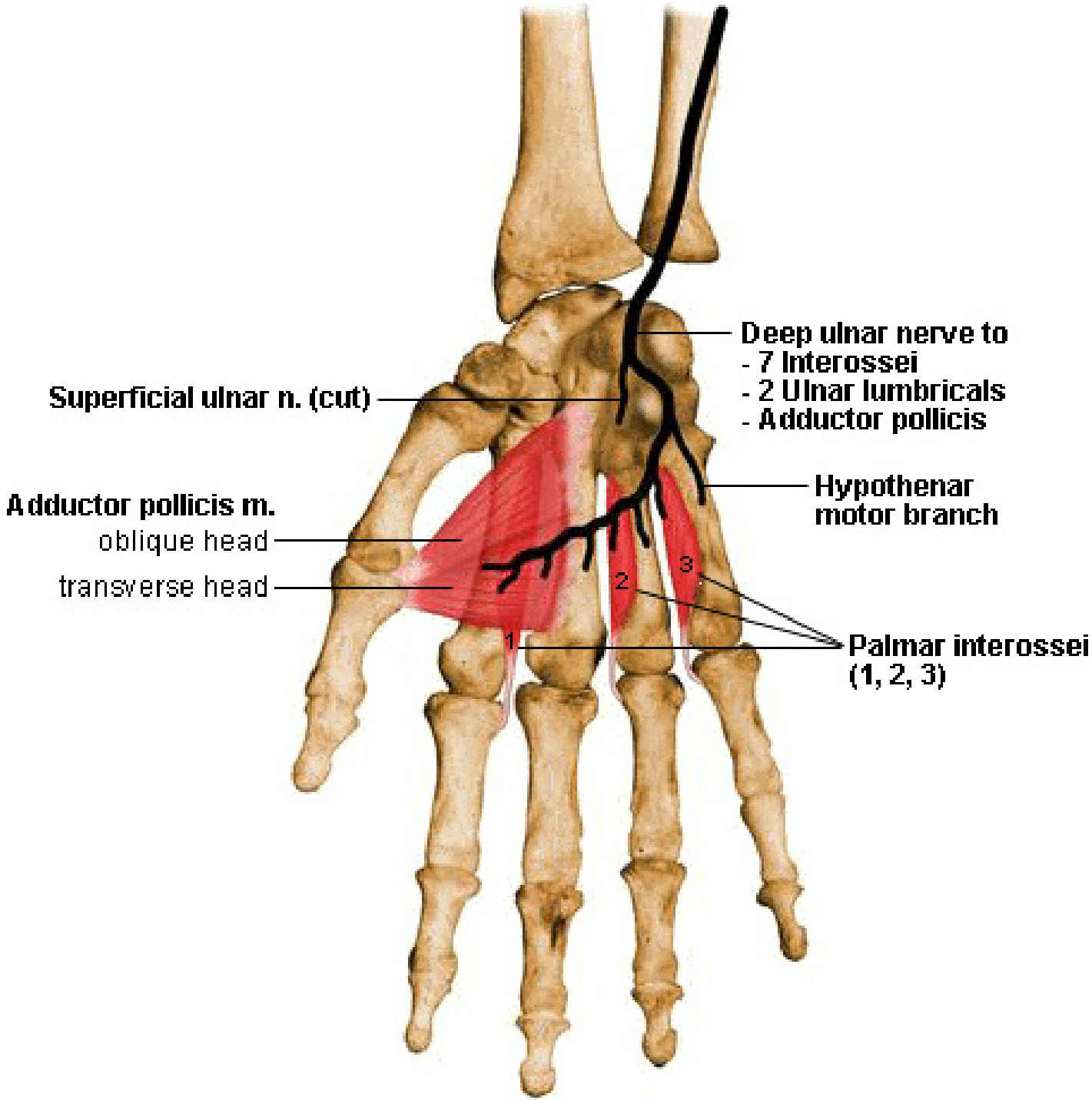
•above the wrist, the ulna nerve gives off a dorsal sensory branch, which courses dorsally across the ulnar styloid to supply sensory innervation to the dorsum of the ulnar one half of the hand

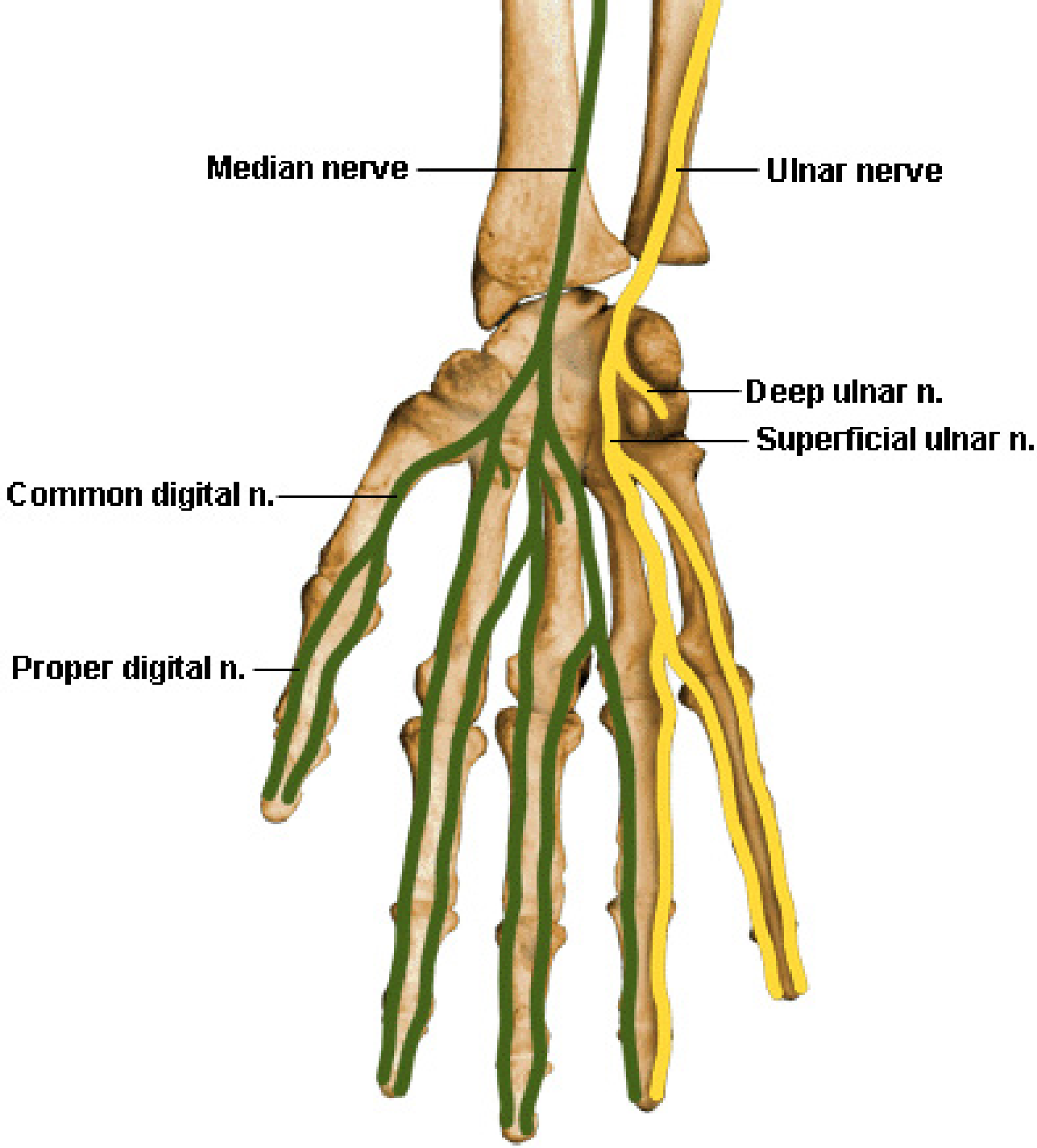
•in the hand, the main ulna nerve first innervates the ***hypothenar muscles*** (abductor digiti minimi, flexor digiti minimi brevis and opponens digiti minimi)

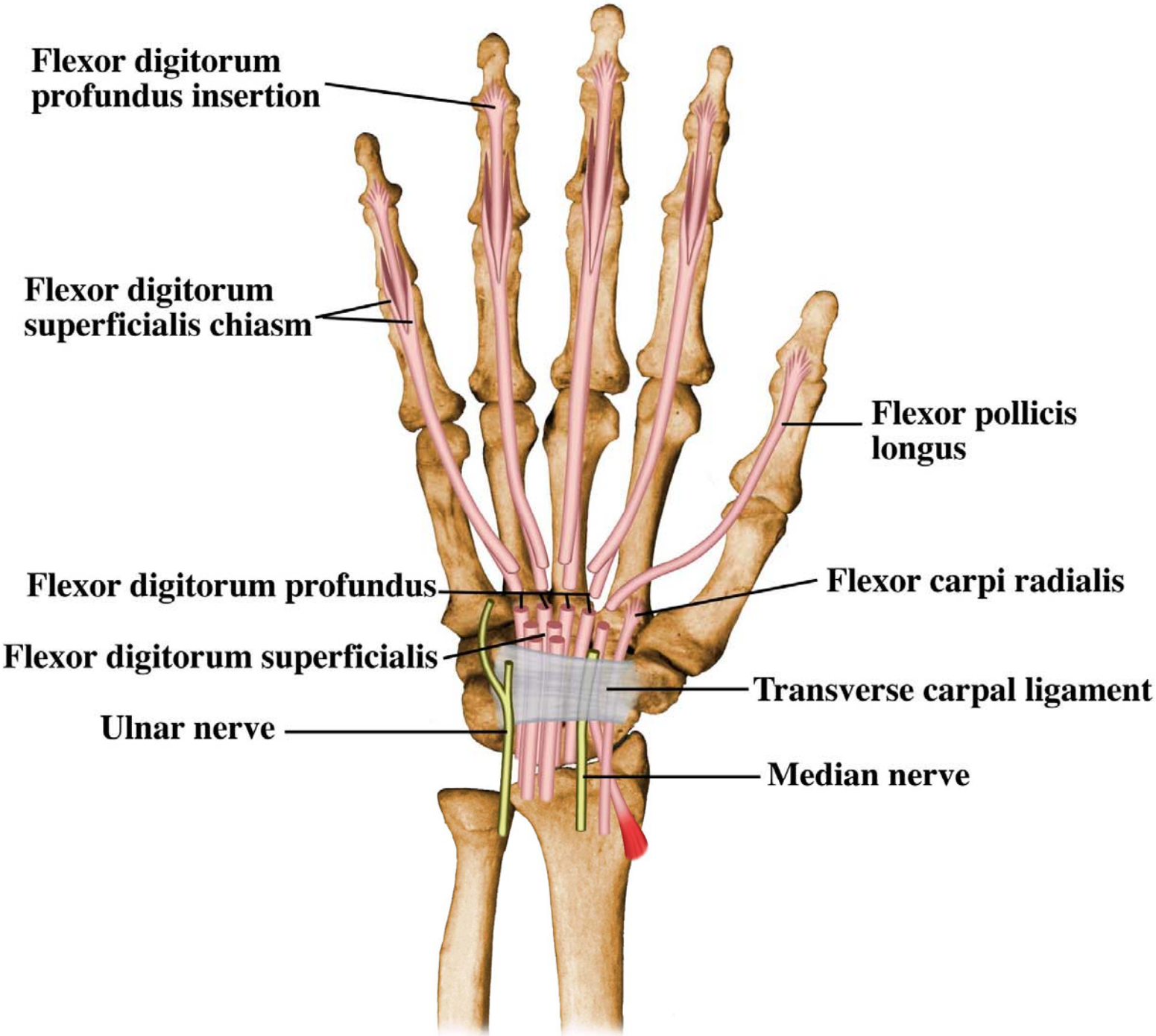
•then innervates the ***ulnar lumbricals*** **(4th and 5th), all of the dorsal interossei,** the ***adductor pollicis*** (major muscle of pinch) and the **deep head of the *flexor pollicis brevis*** (the rest of that muscle is usually innervated by the median nerve)

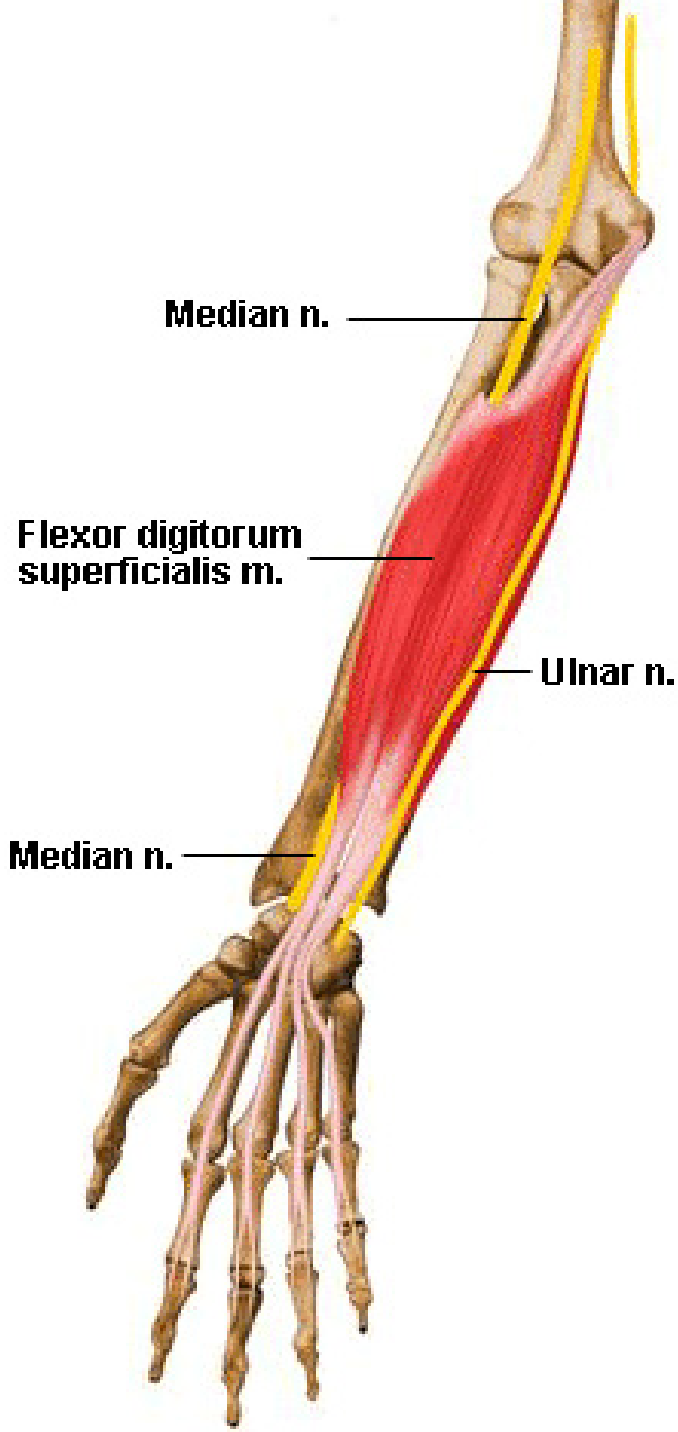
•the sensory nerves to the palmar aspect of the ulnar one and a half fingers come off the ulna nerve at the base of the palm just beyond the ulna styloid


Ulnar Nerve (C8; T1)
(only muscles innervated by ulnar nerve are depicted)
Cutaneous innervation
Ulnar nerve (no branches above elbow)
Articular branch (behind medial condyle)
Flexor digitorum profundus m. (medial portion only; lateral portion supplied by anterior interosseous branch of median n.)
Flexor carpi ulnaris m. (drawn aside)
Dorsal branch
Palmar branch
Flexor pollicis brevis m. (deep head only; superficial head and other thenar muscles supplied by median n.)
Superficial branch
Deep branch
Adductor pollicis m.
Palmaris brevis
Abductor digiti minimi
Flexor digiti minimi brevis
Opponens digiti minimi
Hypothenar muscles
Common palmar digital n.
Anastomotic branch to median n.
Palmar and dorsal interosseous mm.
3rd and 4th lumbrical mm. (turned down)
Proper palmar digital nn. (dorsal digital nn. are from dorsal branch)
Branches to dorsum of middle and distal phalanges

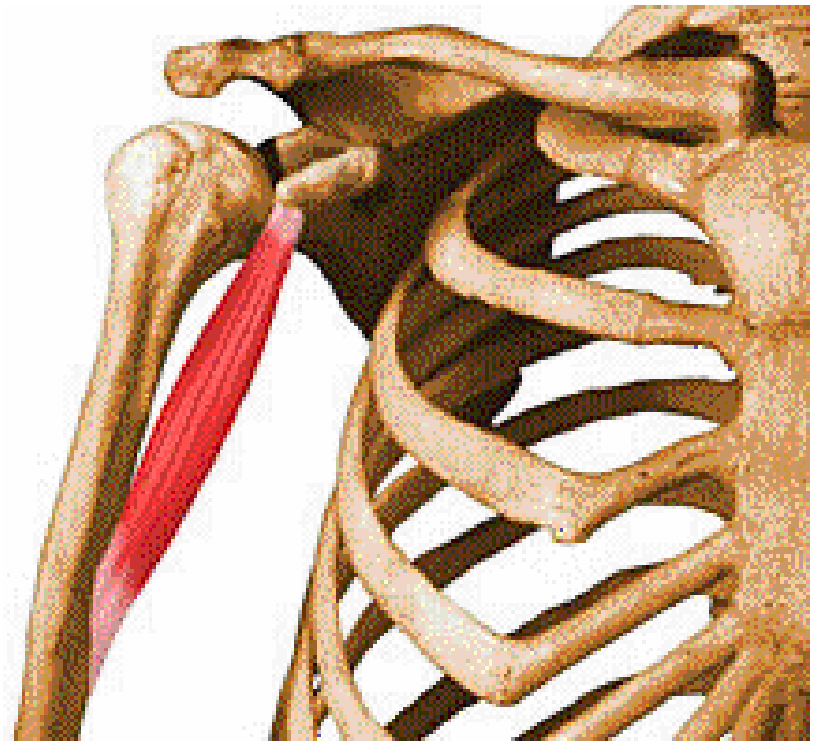

Deep ulnar nerve to
- 7 Interossei
- 2 Ulnar lumbricals
- Adductor pollicis
Superficial ulnar n. (cut)
Hypothenar
motor branch
Adductor pollicis m.
oblique head
transverse head
1
2
3
Palmar interossei
(1, 2, 3)


Median nerve
Ulnar nerve
Deep ulnar n.
Superficial ulnar n.
Common digital n.
Proper digital n.

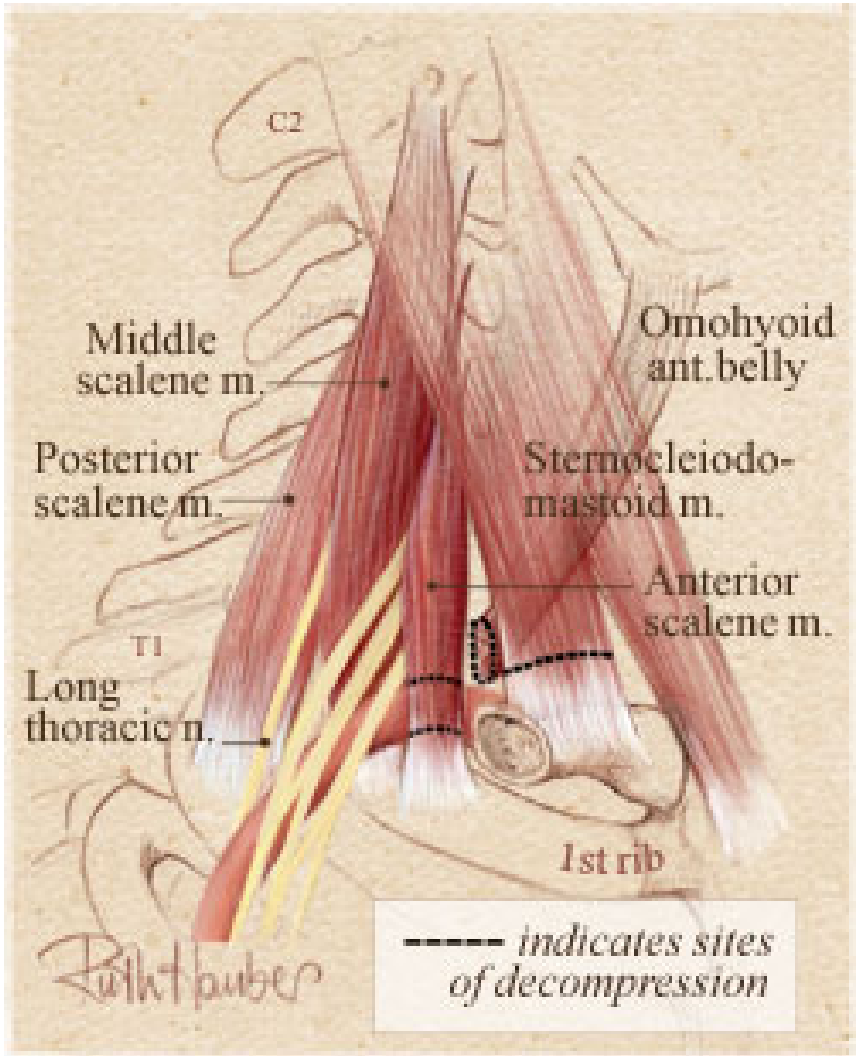

Flexor digitorum profundus insertion
Flexor digitorum superficialis chiasm
Flexor pollicis longus
Flexor digitorum profundus
Flexor carpi radialis
Flexor digitorum superficialis
Transverse carpal ligament
Ulnar nerve
Median nerve


Median n.
Flexor digitorum superficialis m.
Ulnar n.
Median n.

Musculocutaneous Nerve

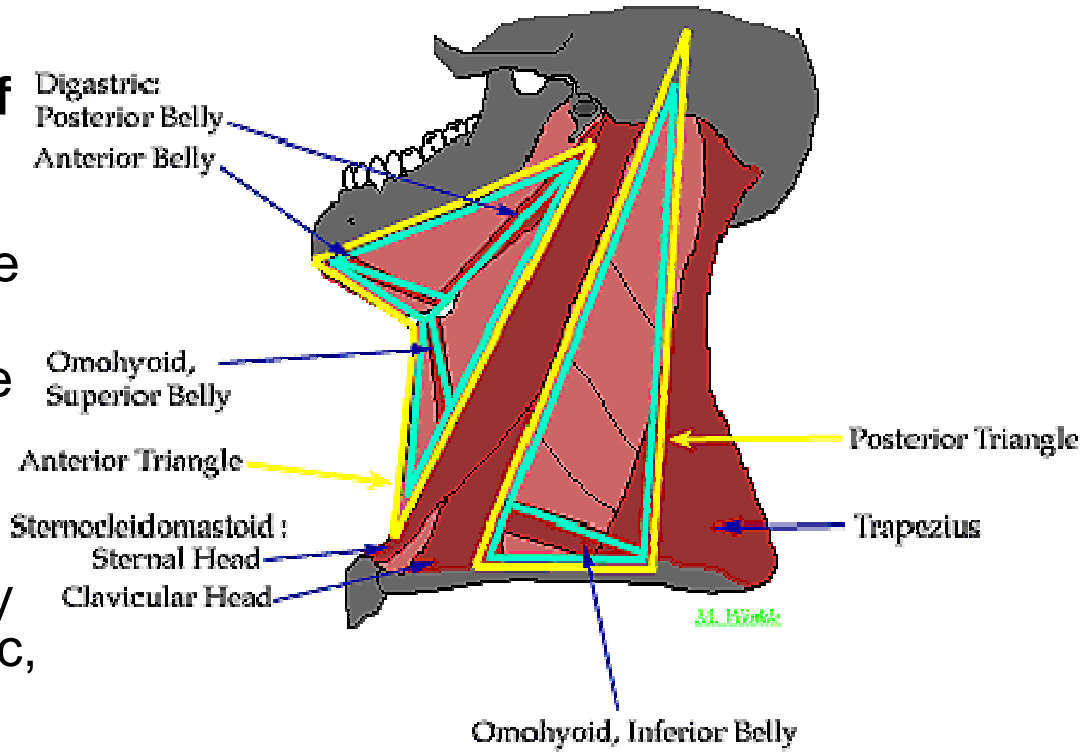


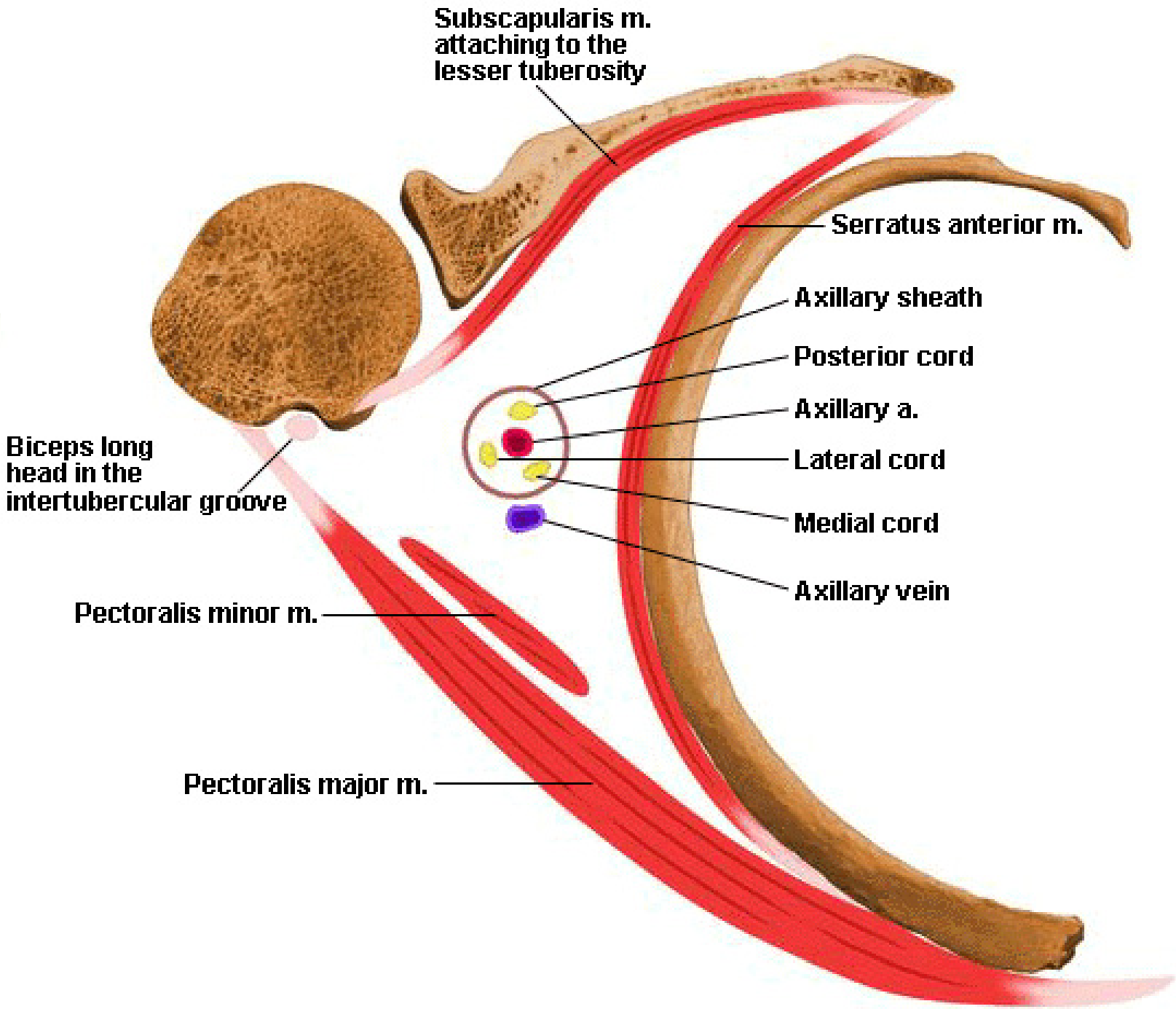
Coracobrachialis Muscle

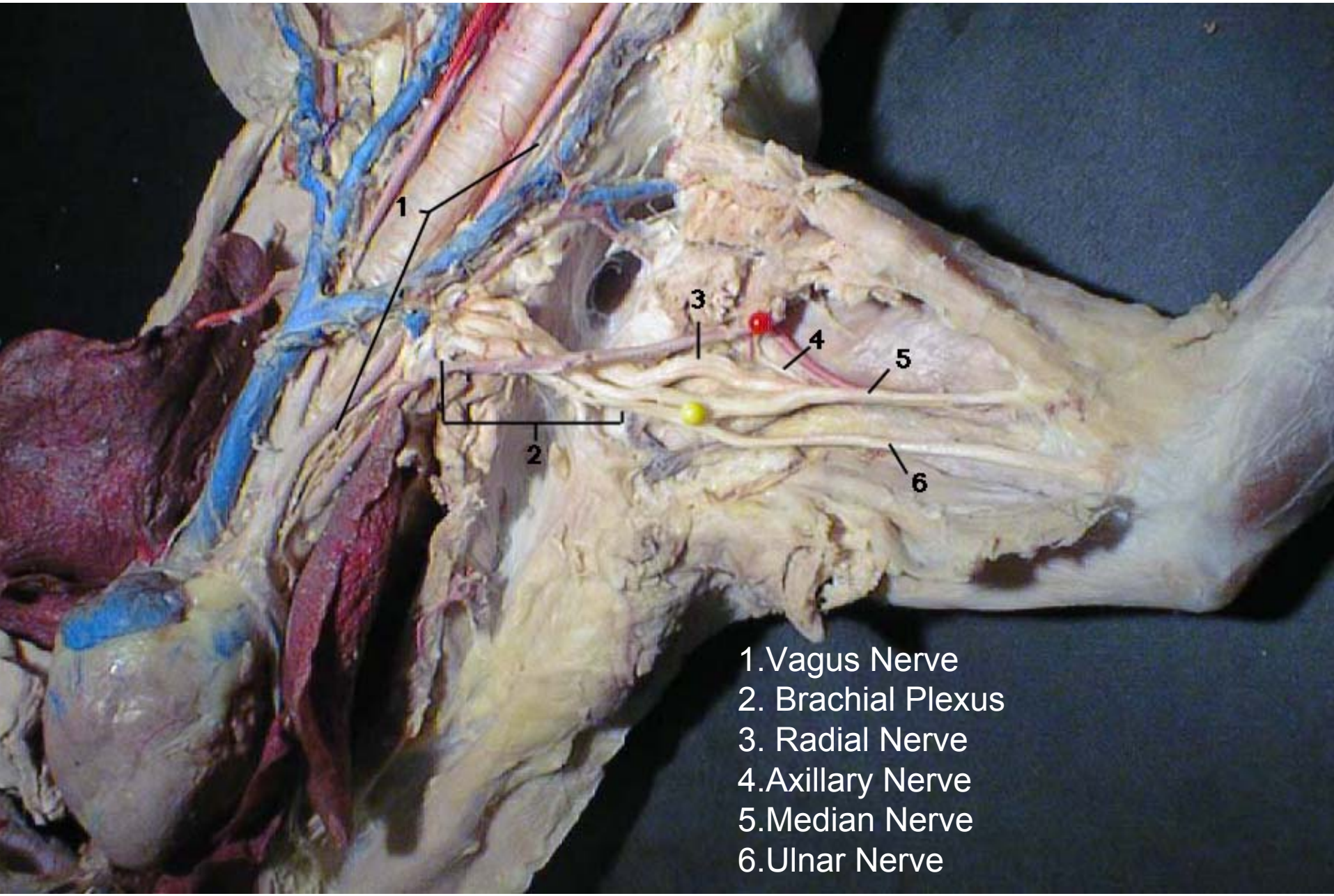

C2
Middle scalene m.
Posterior scalene m.
T1
Long thoracic n.
Omohyoid ant.belly
Sternocleiodo-mastoid m.
Anterior scalene m.
1st rib
----- indicates sites of decompression

Brachial Plexus

- **origin is the anterior triangle of the neck**
- **bordered by the anterior border of the SCM, midline of the neck, and the mandible**
- **muscular triangle**--formed by the midline, superior belly of the omohyoid, and SCM
- **carotid triangle**--formed by the superior belly of the omohyoid, SCM, and posterior belly of the digastric
- **submental triangle**--formed by the anterior belly of the digastric, hyoid, and midline
- **submandibular triangle**--formed by the mandible, posterior belly of the digastric, and anterior belly of the digastric

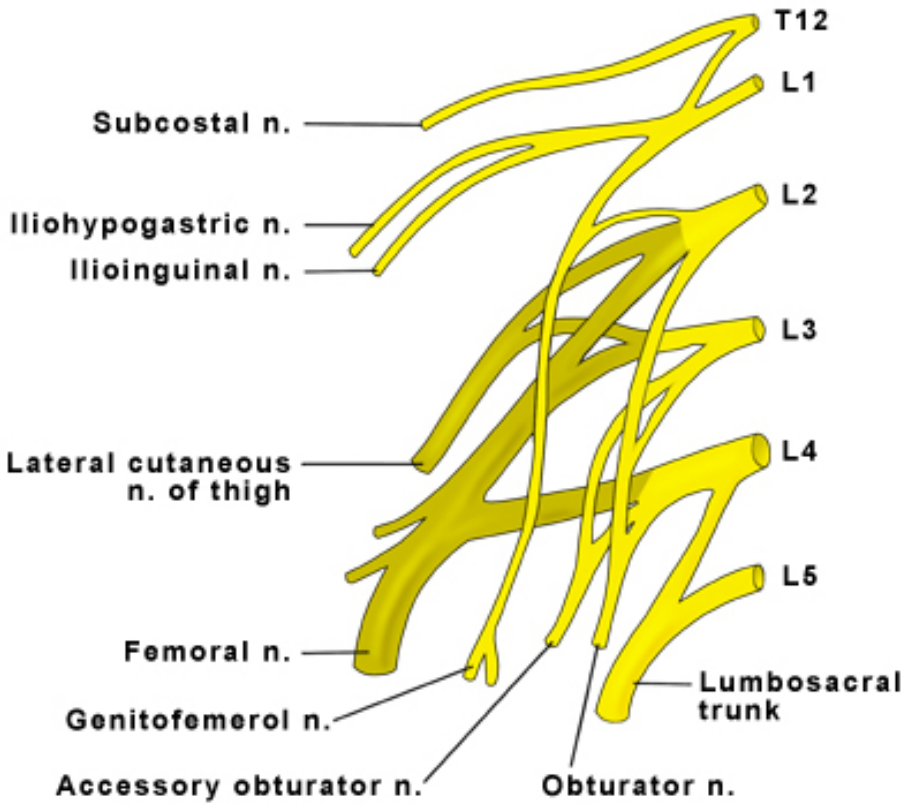



Subscapularis m. attaching to the lesser tuberosity
Serratus anterior m.
Axillary sheath
Posterior cord
Axillary a.
Lateral cord
Medial cord
Axillary vein
Biceps long head in the intertubercular groove
Pectoralis minor m.
Pectoralis major m.


1
2
3
4
5
6
1.Vagus Nerve
2. Brachial Plexus
3. Radial Nerve
4.Axillary Nerve
5.Median Nerve
6.Ulnar Nerve

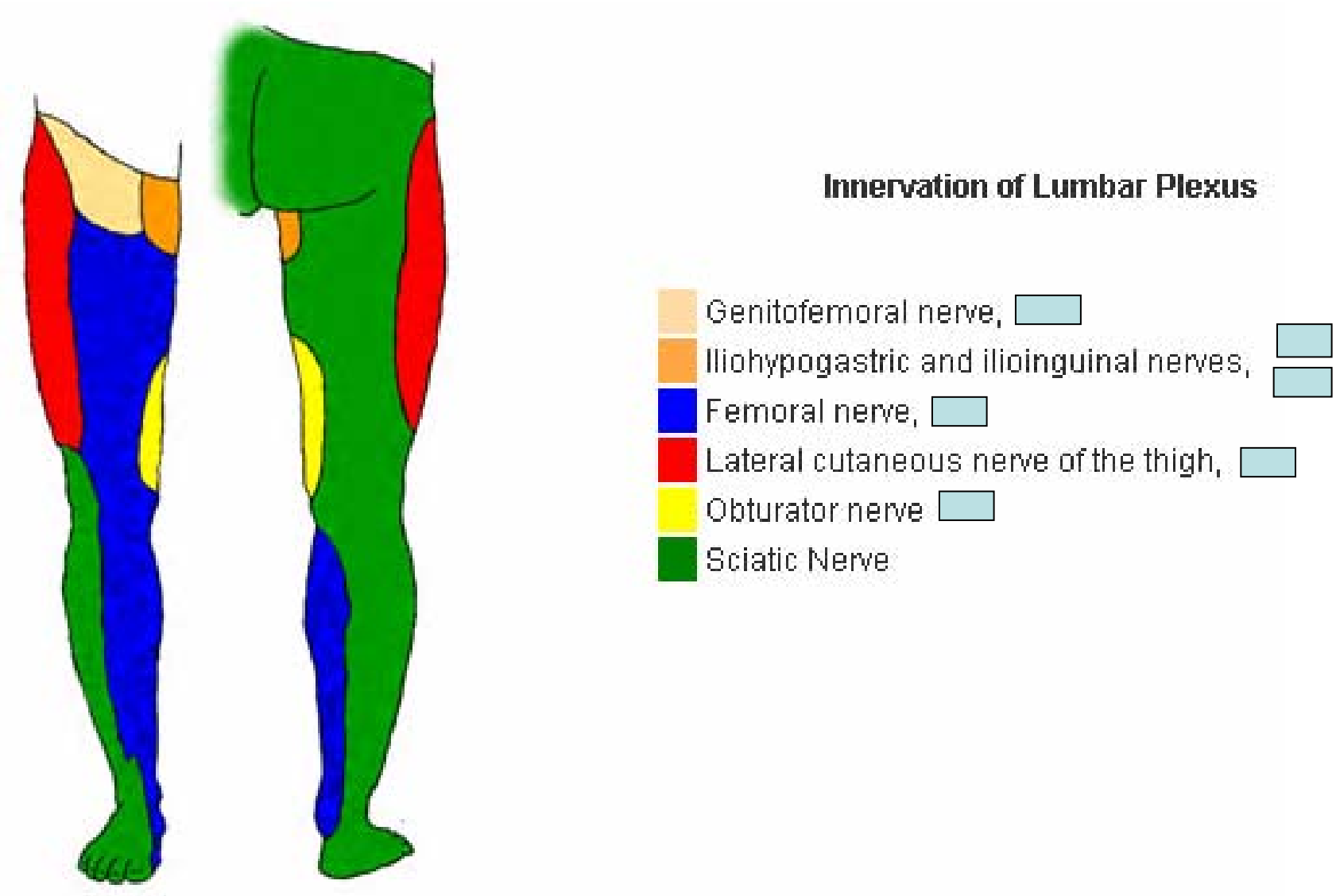
Lumbar Plexus

- formed from the ventral rami of nerves L1-L4 and some fibers from T12, forming
  - **iliohypogastric nerves**
  - **ilioinguinal nerve**
  - **genitofemoral nerve**
  - **lateral femoral cutaneous nerve**
  - **femoral nerve**
  - **saphenous nerve**
  - **obturator nerve**



next slide

Cutaneous Innervation of Lumbar Plexus

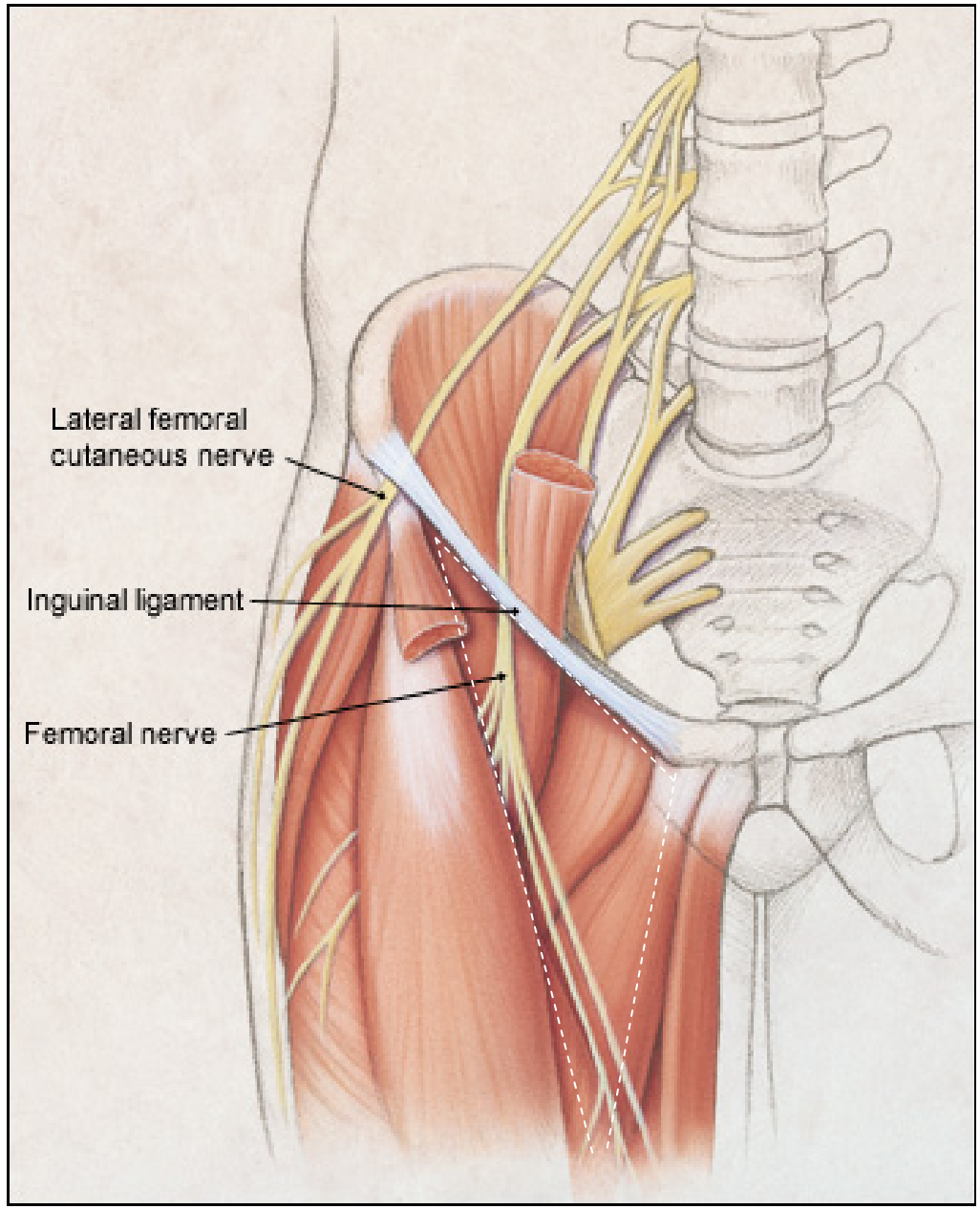


Lateral Femoral Cutaneous Nerve

lateral femoral cutaneous nerve- somatosensory only to skin of lateral aspect of thigh.

Femoral nerve

- largest branch of lumbar plexus
- motor and somatosensroy
  - skin of anterior and lateral thigh, medial leg and foot
  - anterior muscles of thigh and extensors of leg; **iliacus**, **psoas major**, **pectineus**, **quadriceps femoris** (rectus femoris, vastus intermedius, vastus lateralis and vastus medialis), and **sartorius**



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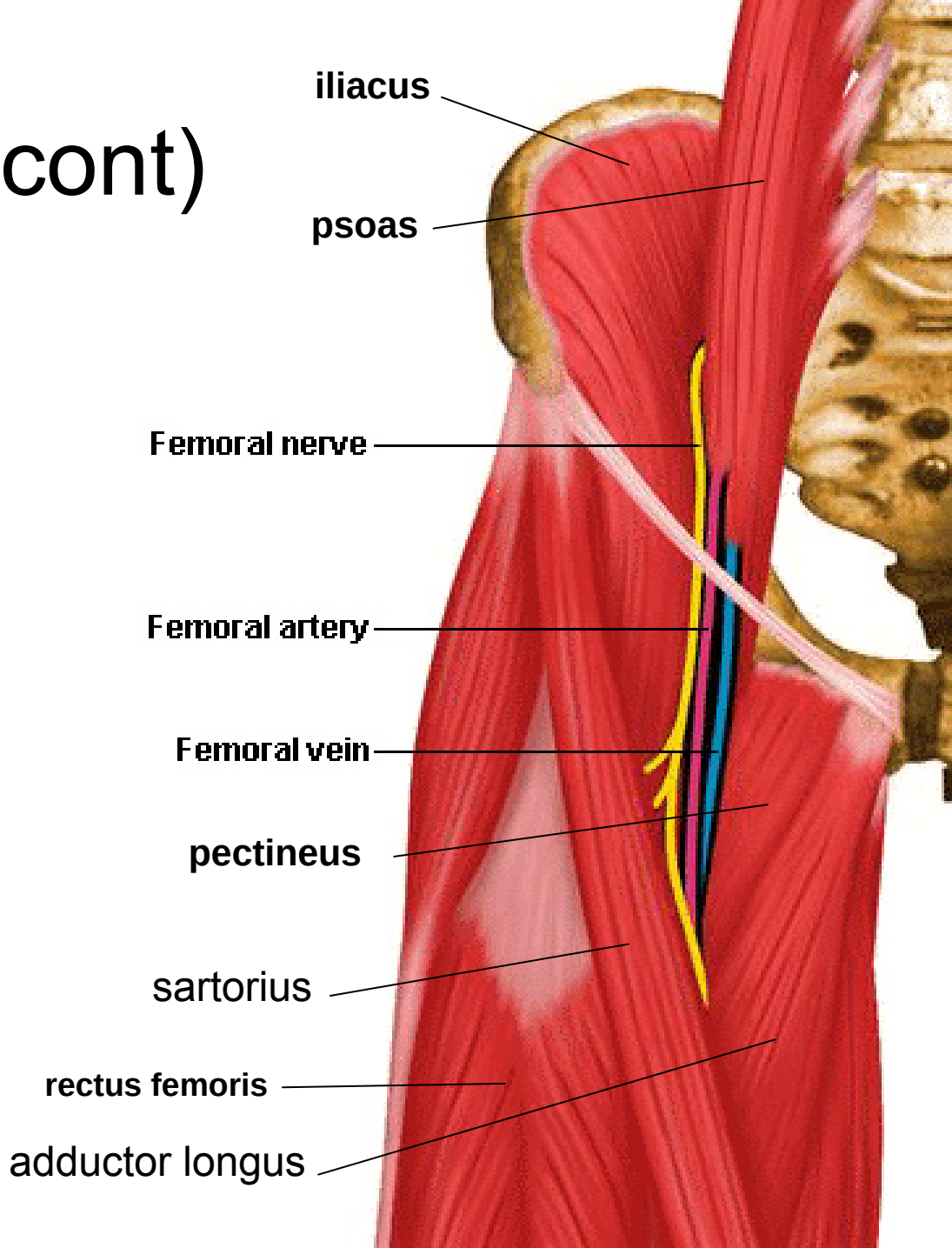
Femoral Nerve (cont)

It is in the femoral triangle where the femoral nerve, over lying the iliacus muscel, that the nerve divides into its muscular and sensory branches.

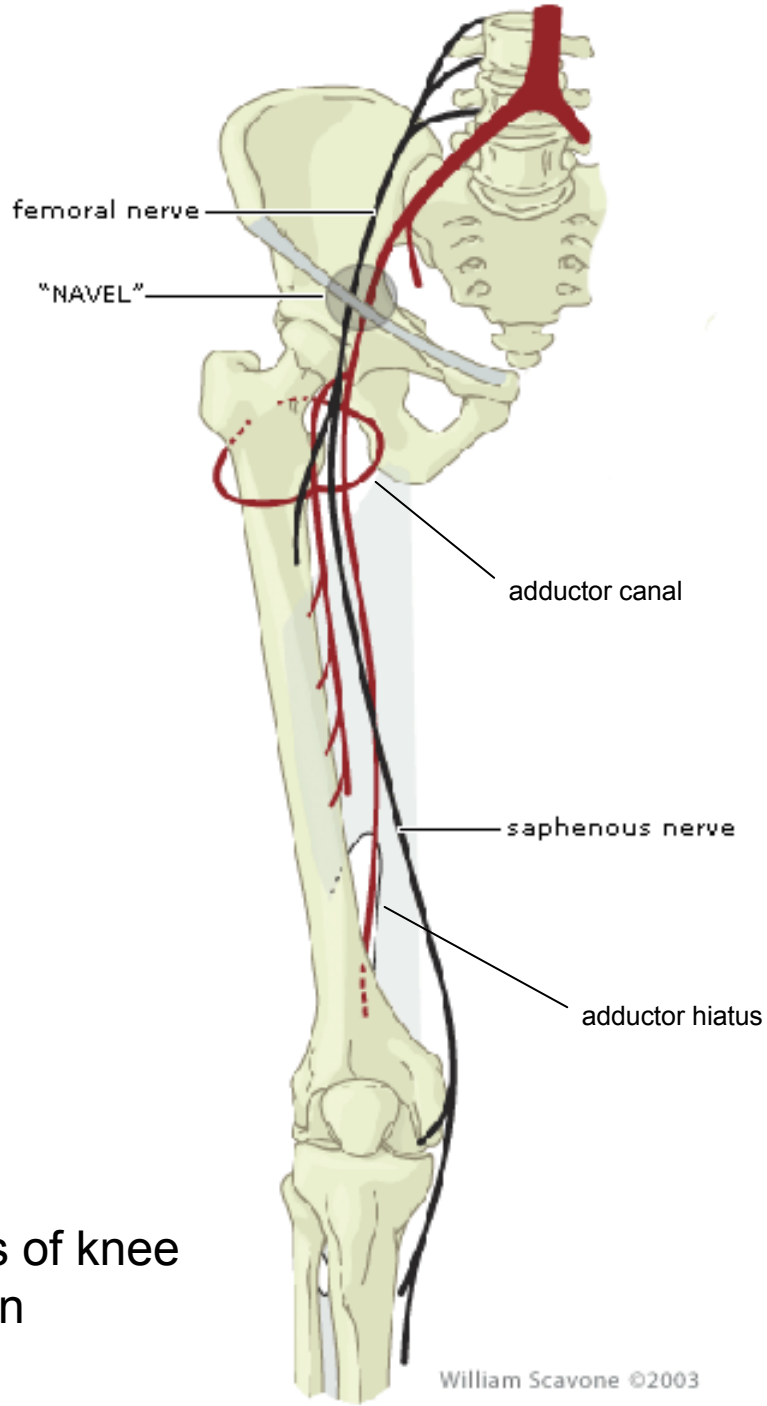
Only the **saphenous nerve** branch enters the **adductor canal**, along with a branch to the vastus medialis muscle.



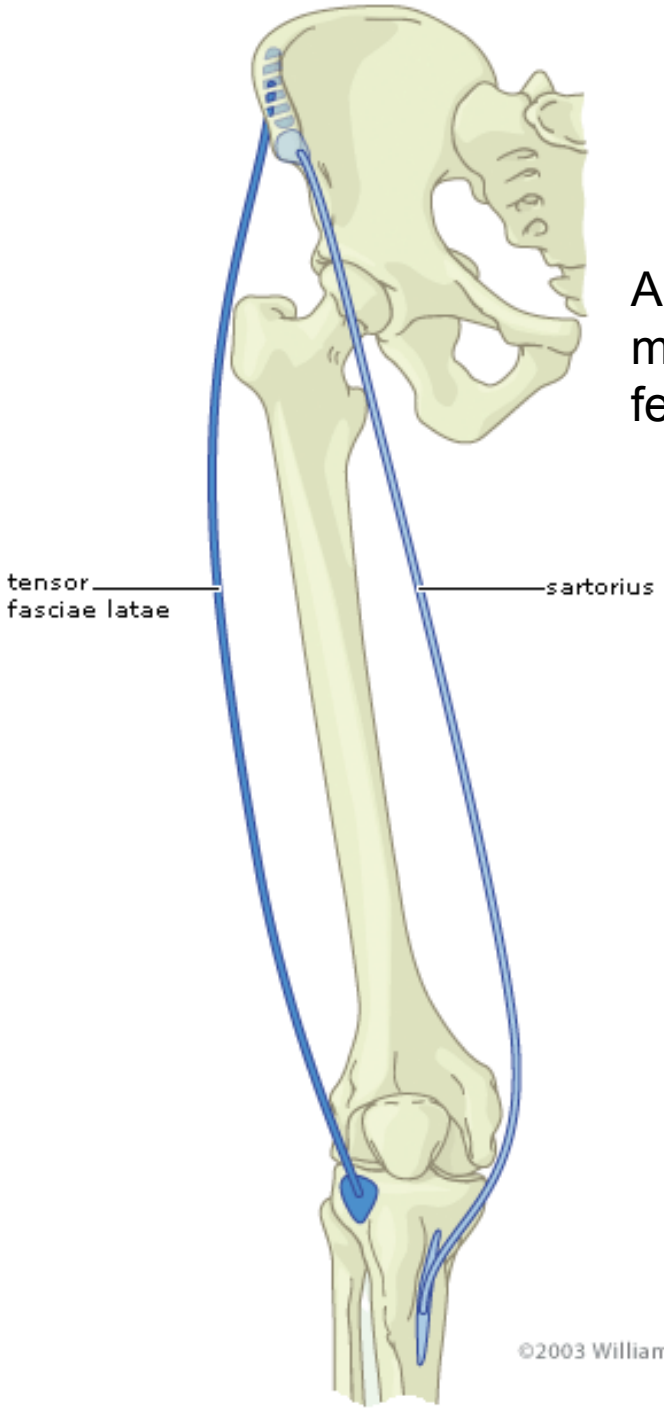
Femoral Nerve Innervates **muscles of the Anterior Thigh**

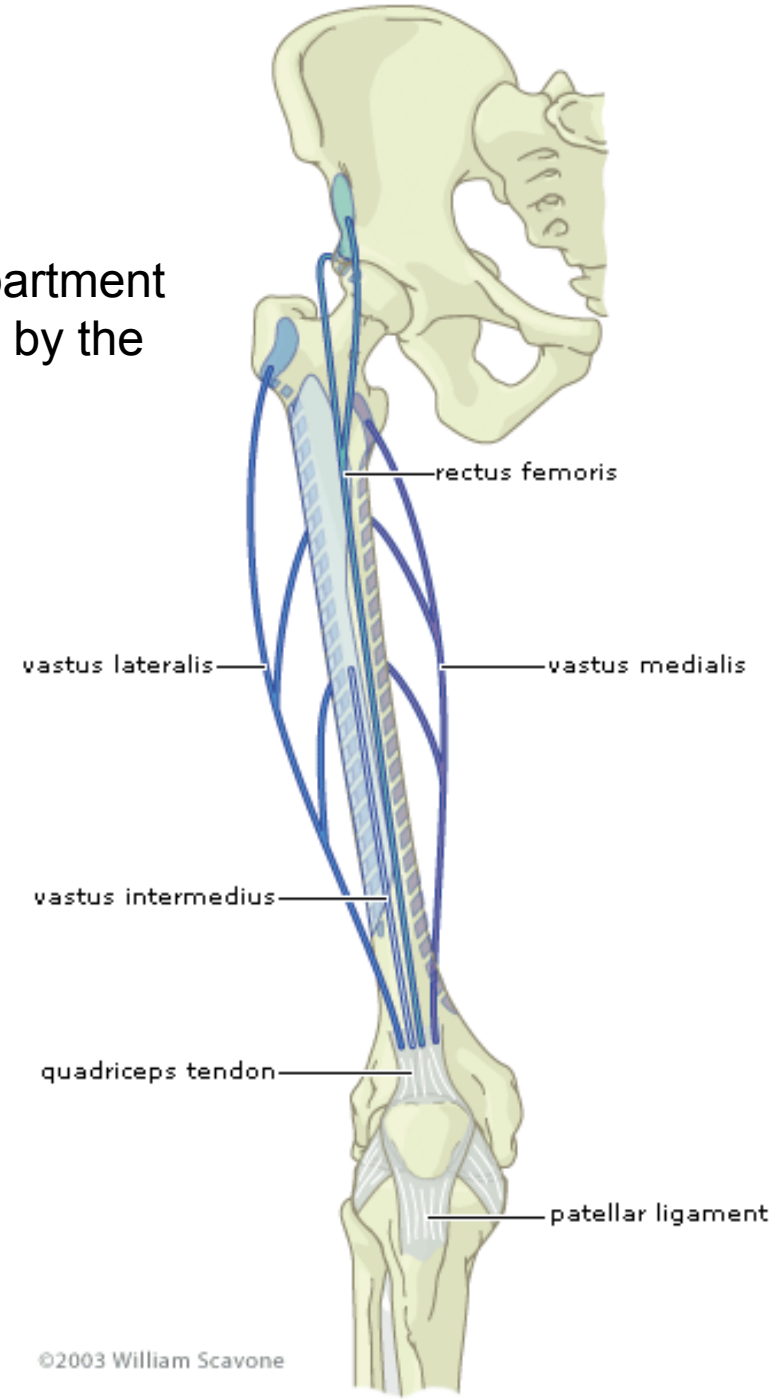
Action: Flex hip, extend knee

Injury to nerve: Weakness of hip flexion, loss of knee extension (no patellar reflex), sensory loss on anteromedial thigh, knee, leg, and foot



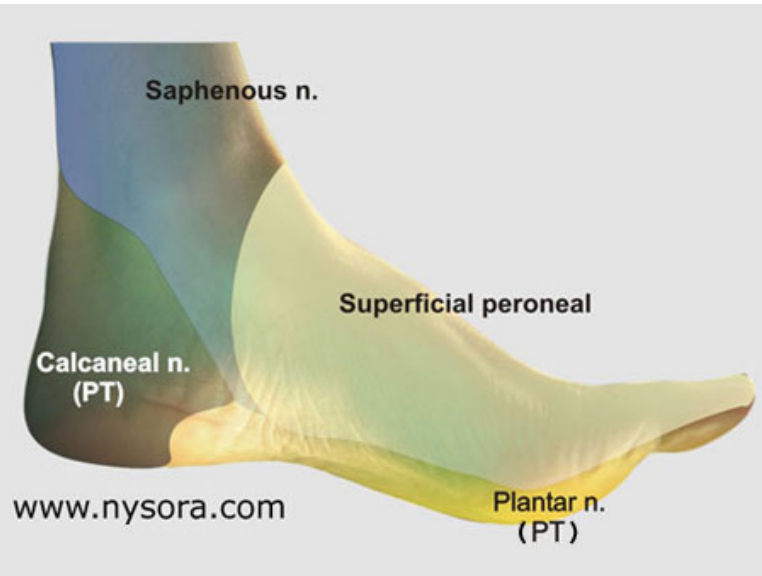
Anterior thigh compartment muscles innervated by the femoral nerve

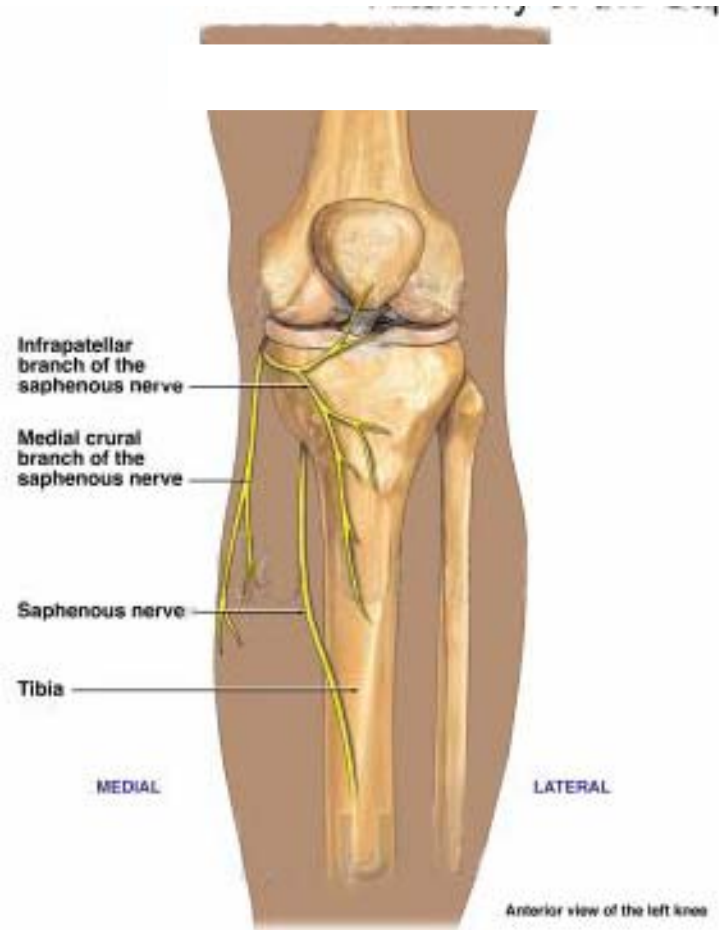




Saphenous Nerve

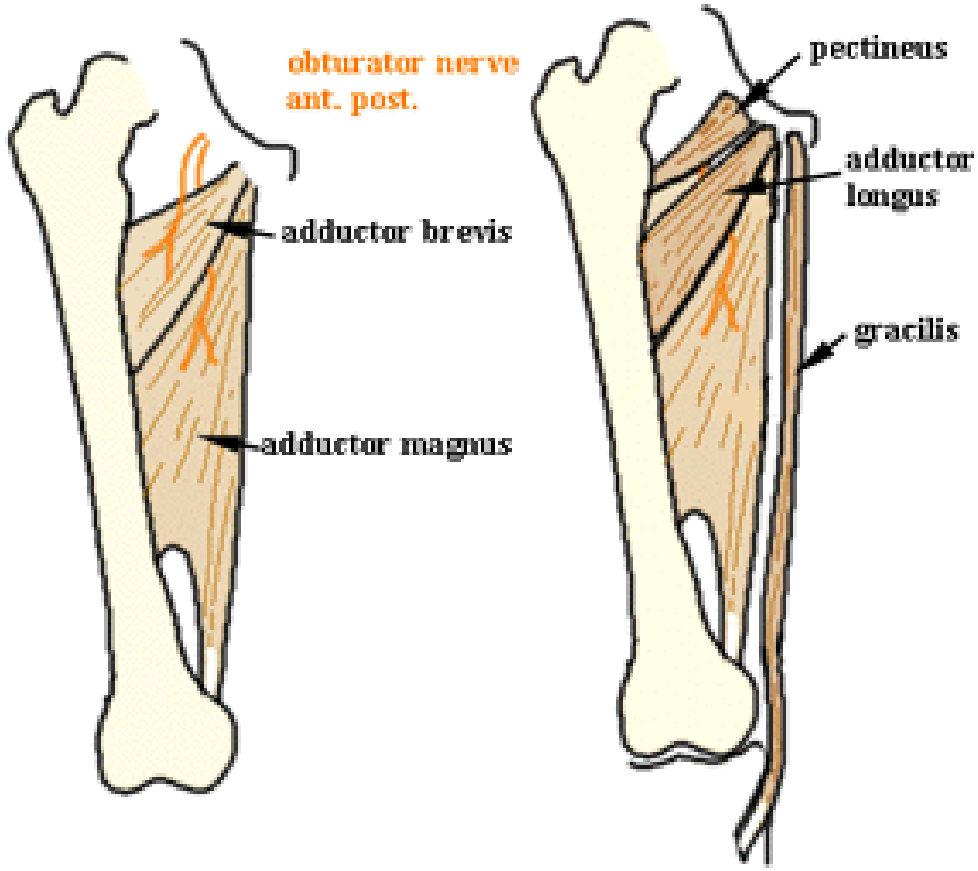
- formed from the posterior division of the femoral nerve
- is the largest cutaneous branch of the femoral nerve.
- innervates skin of medial aspects of leg and foot: knee joint





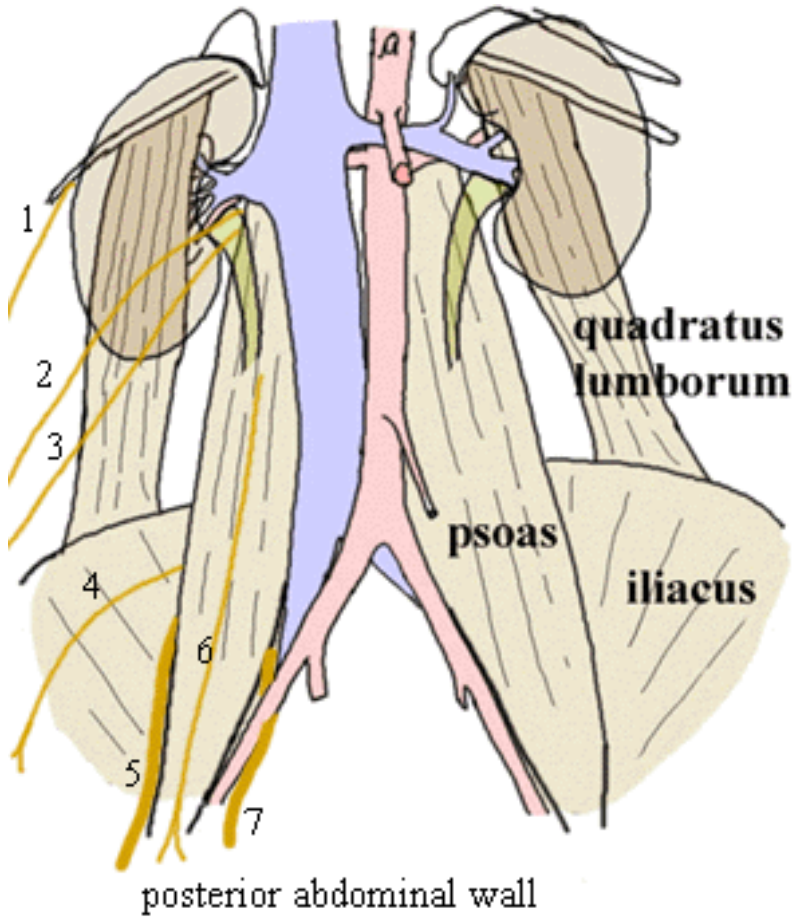
Obturator Nerve

- sensory innervations- skin of superior medial thigh
- motor innervation- **adductor muscles of leg:** external oblique, pectineus, adductor longus, adductor brevis, adductor magnus, and gracilis



iliohypogastric nerve

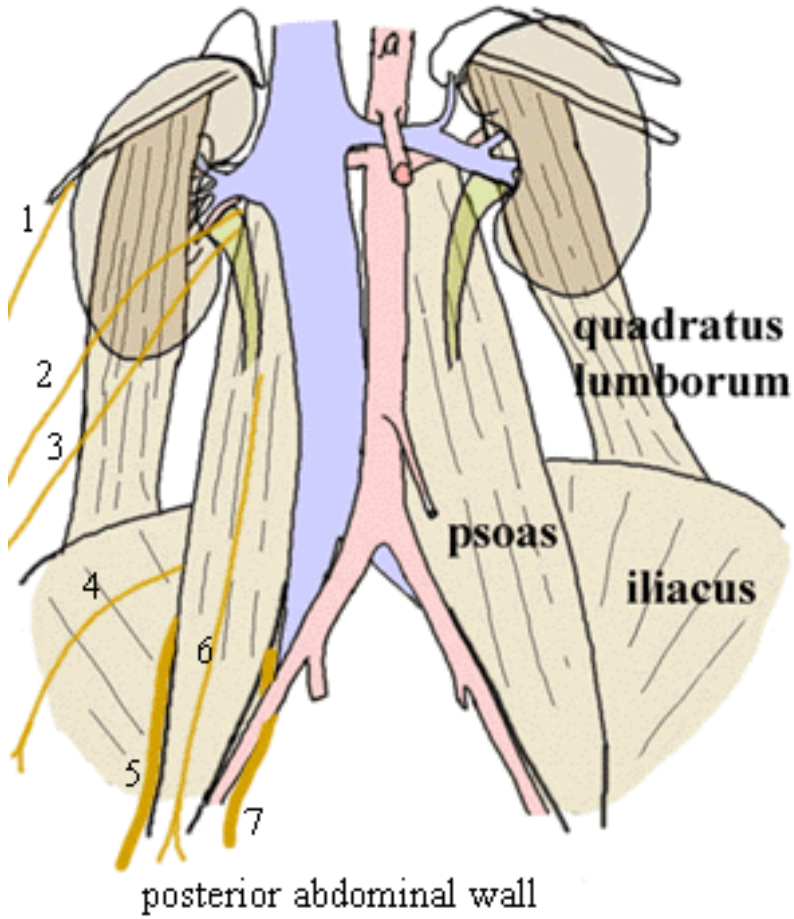
- formed by fibres **from L1**, with some contribution from T12.
- runs obliquely across the quadratus lumborum muscle behind the kidney
- sensory innervation- **skin of anterior abd wall**
- Motor innervation- **internal and external obliques and transversus abdominis**



1. Subcostal nerve 2. Iliohypogastric nerve 3. Ilioinguinal nerve
4. Lateral cutaneous nerve of the thigh 5. Femoral nerve 6. Genitofemoral nerve
7. Obturator nerve

ilioinguinal nerve

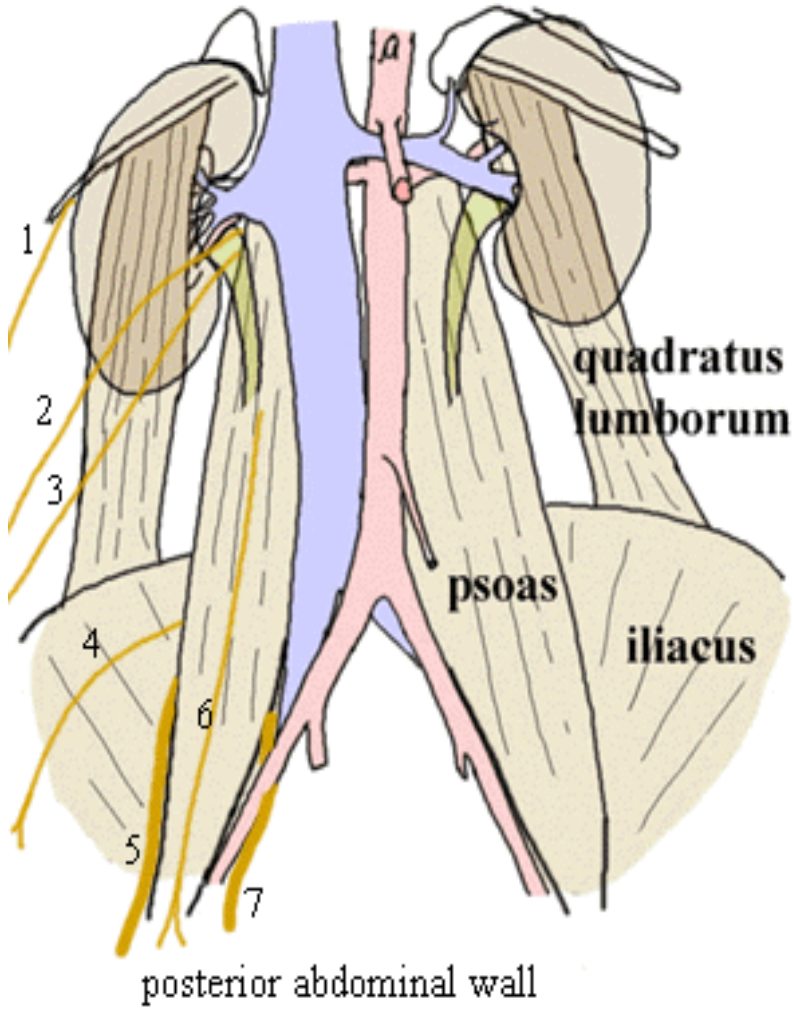
- formed in common with the iliohypogastric nerve.
- sensory innervation- skin of upper medial thigh; male scrotum and root of penis; female labia majora
- motor innervation- joins iliohypogastric nerve and innervates the same muscles



1. Subcostal nerve 2. Iliohypogastric nerve 3. Ilioinguinal nerve 4. Lateral cutaneous nerve of the thigh 5. Femoral nerve 6. Genitofemoral nerve 7. Obturator nerve

Genitofemoral Nerve

- formed from L1,2 and passes through the psoas to emerge on its anterior surface.
- runs down wards on the psoas and divides into genital and femoral branches.
- sensory innervation- **skin** of middle anterior thigh; **male scrotum** and **cremaster muscle**; female labia majora



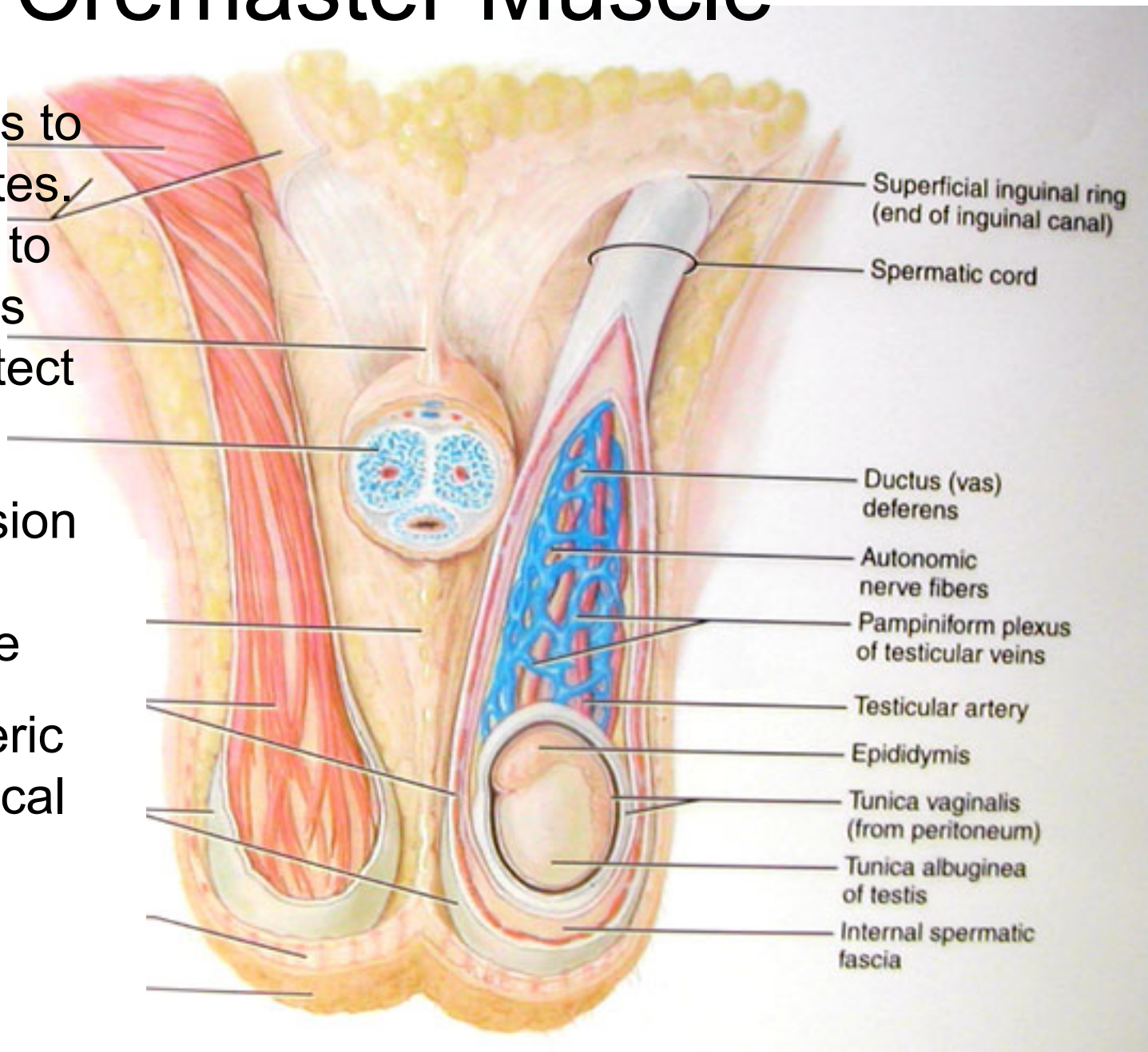
1. Subcostal nerve 2. Iliohypogastric nerve 3. Ilioinguinal nerve
4. Lateral cutaneous nerve of the thigh 5. Femoral nerve 6. Genitofemoral nerve
7. Obturator nerve

Cremaster Muscle

Cremaster acts to retract the testes. This functions to keep the testes warm and protect from injury.

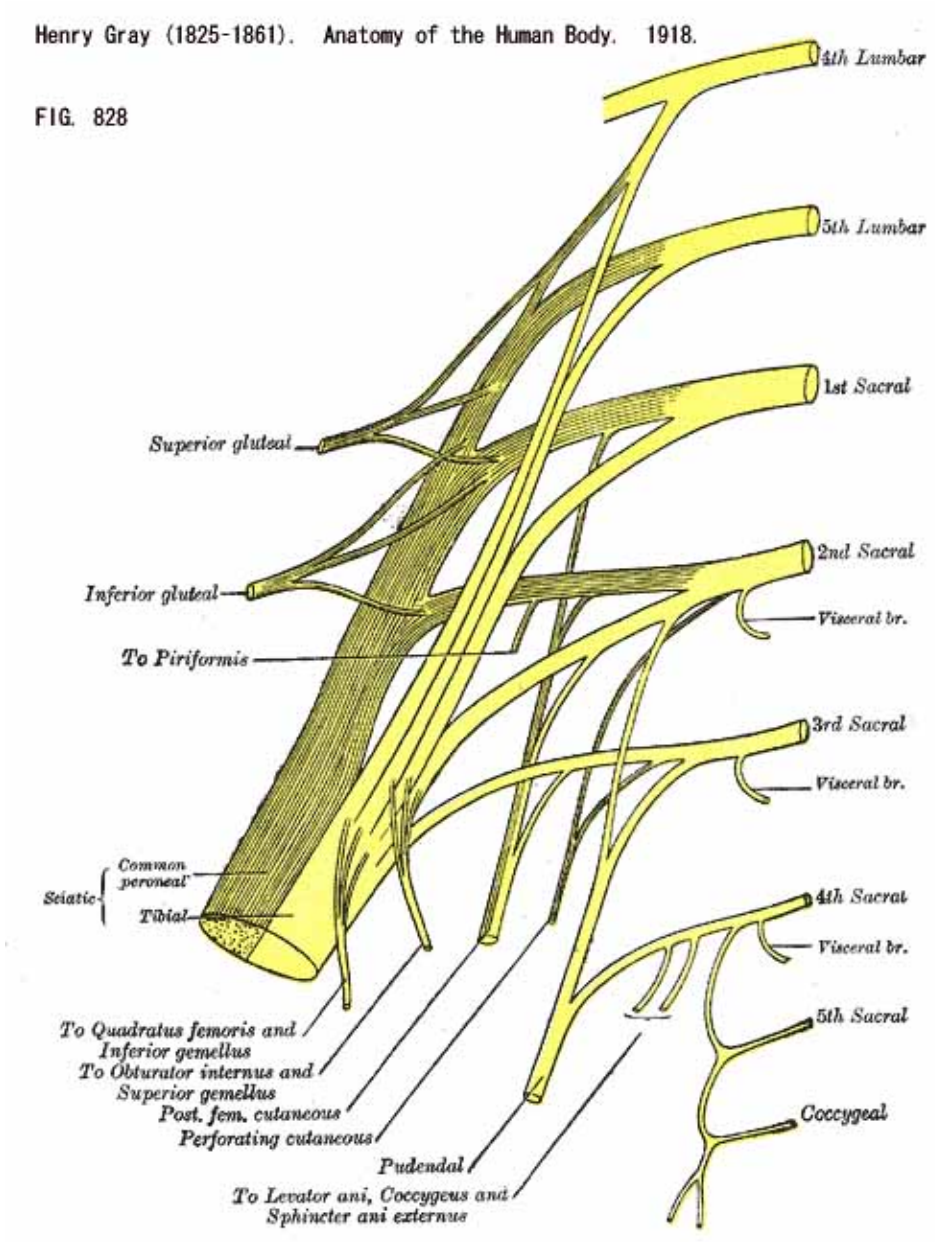
•it is an extension of the internal oblique muscle

•The cremasteric reflex is a clinical test of the muscle.

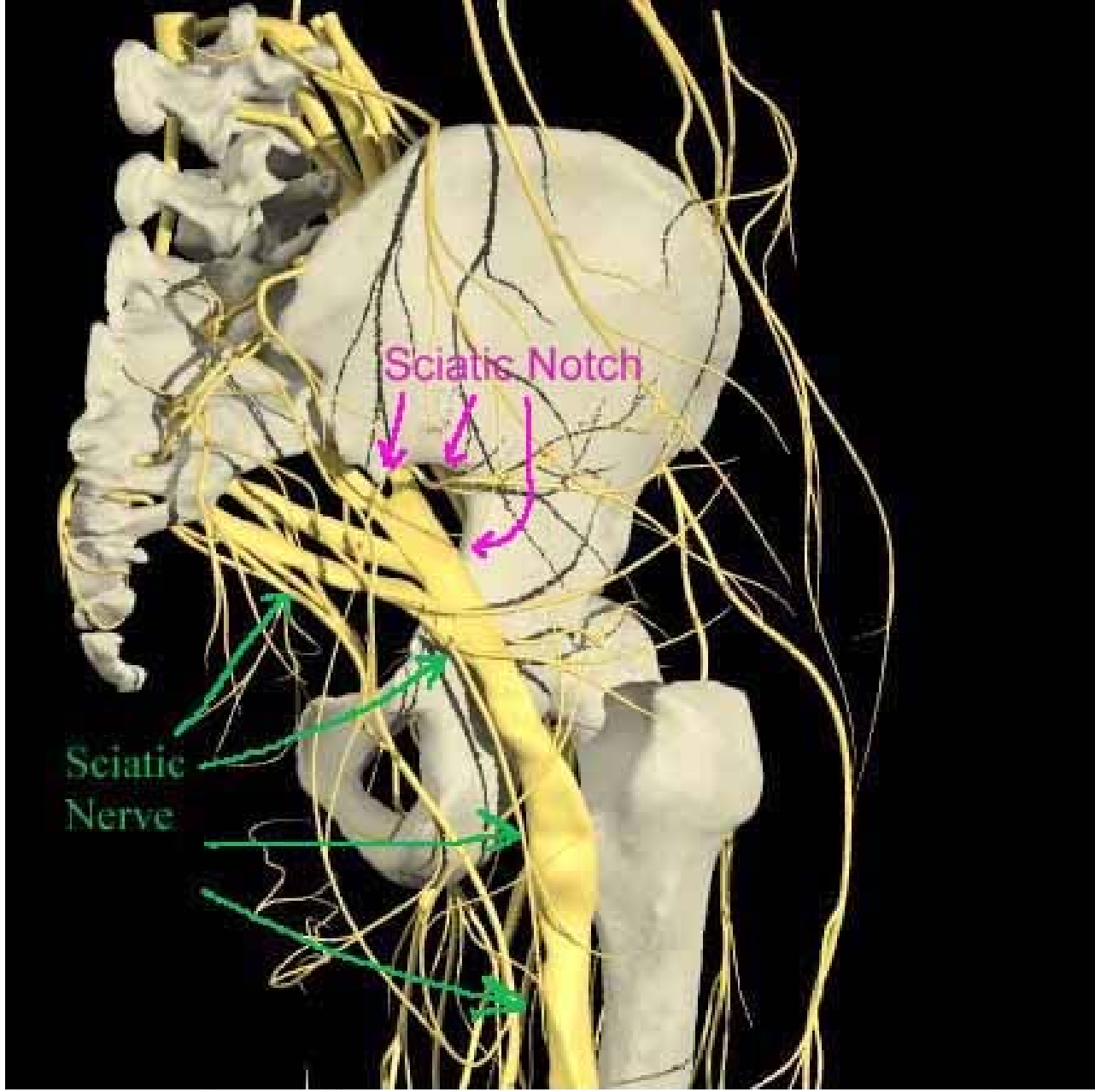


Sacral Plexus

- Nerve roots from L4-S3 merge to form the sacral plexus



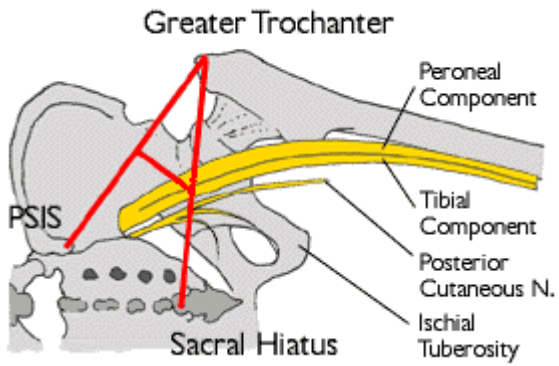
- After merging, the sacral plexus passes through a boney notch in the pelvis known as the **Greater Sciatic Notch** (Greater Sciatic Foramen).
- It is here that the sciatic nerve gets its name.

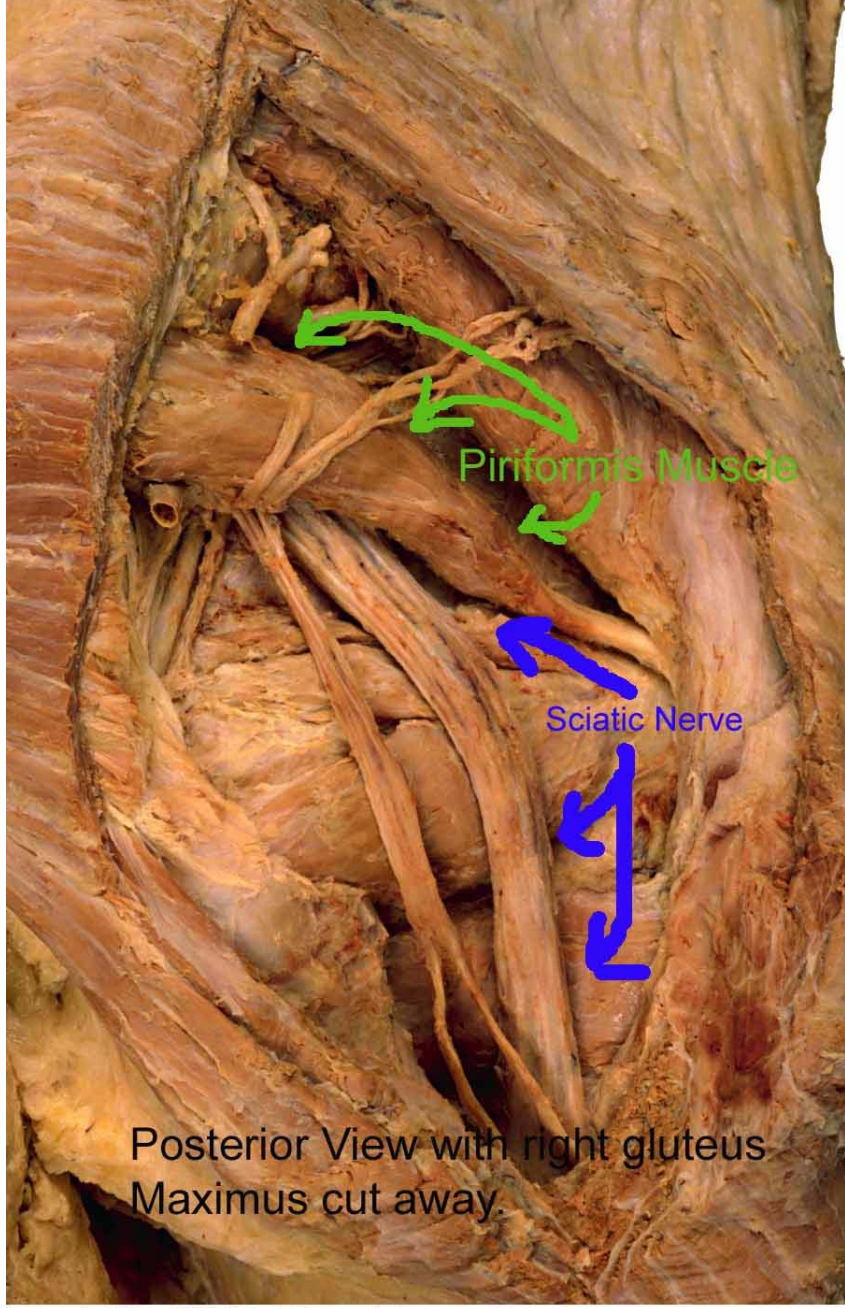


Next, it passes under or through a muscle called the Piriformis Muscle

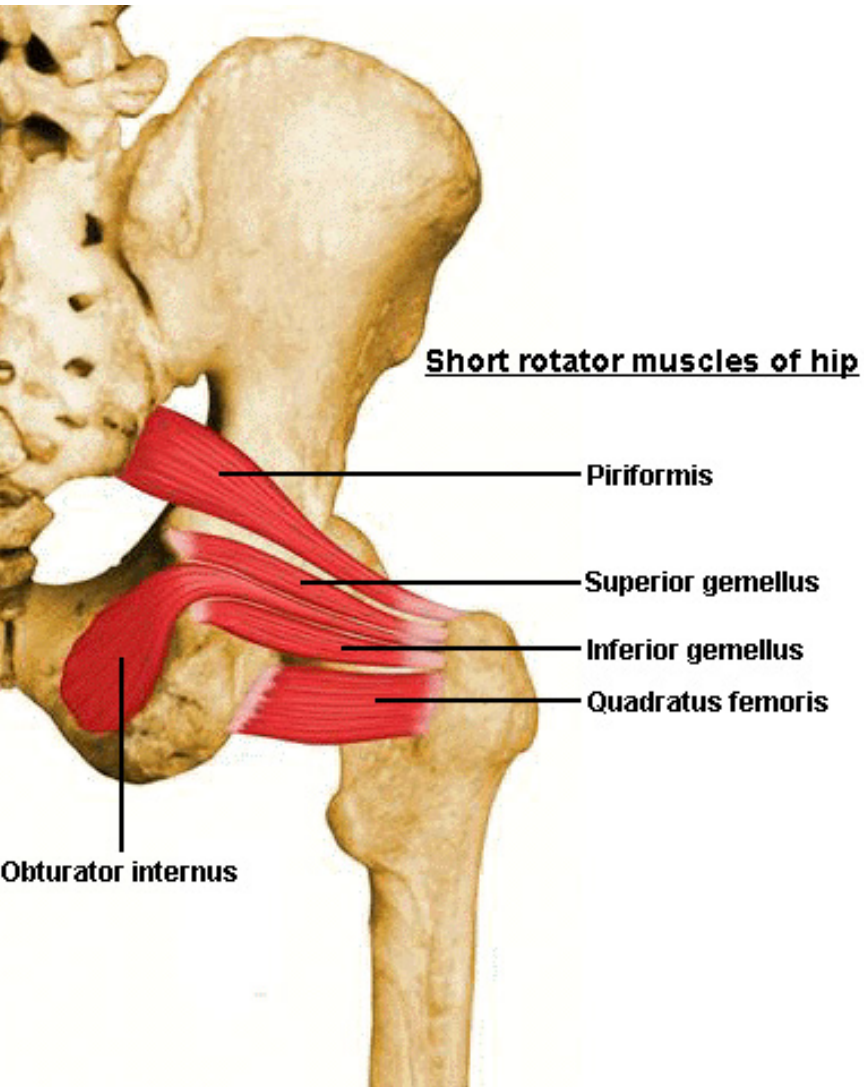
Here, it divides to form the

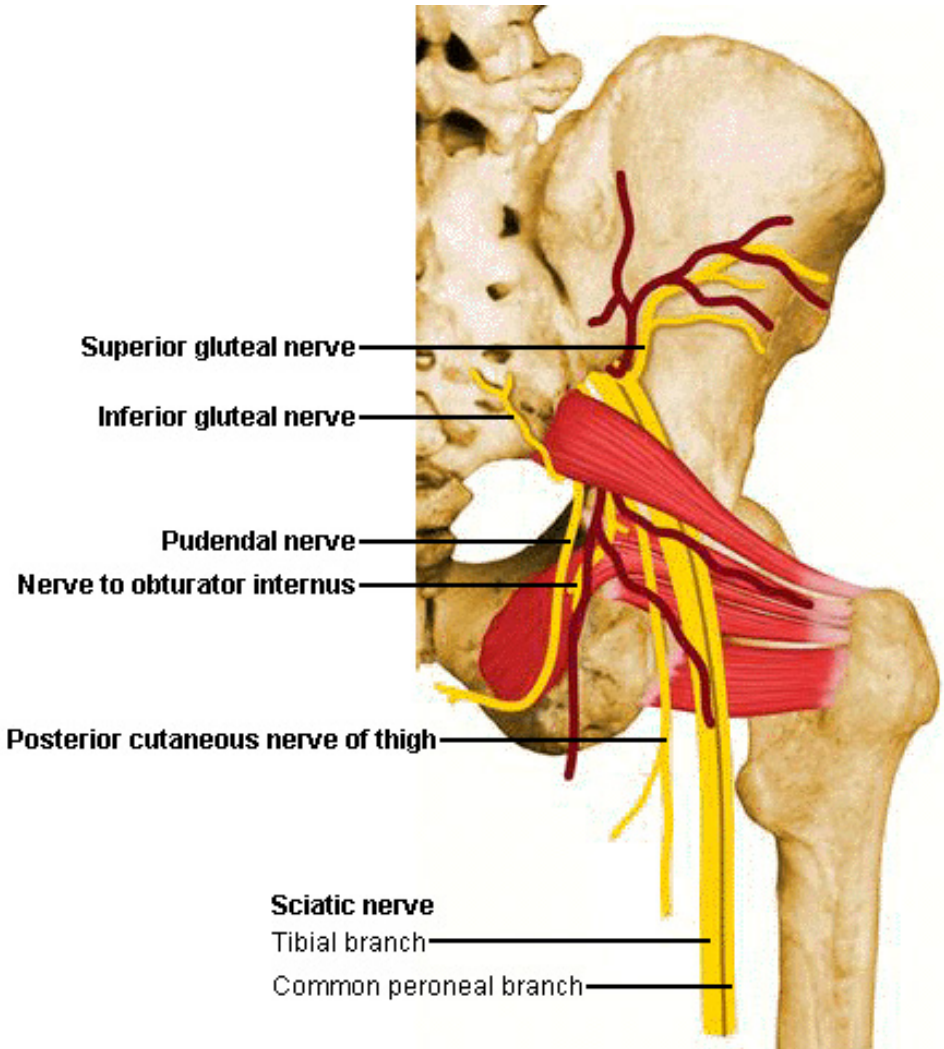
- **lateral common peroneal-** supplies fibres to the **short head of biceps femoris**.
- **medial tibial divisions-** supplies the **semimembranosus, semitendinosus**, the ischial head of **adductor magnus** and **long head of biceps femoris**

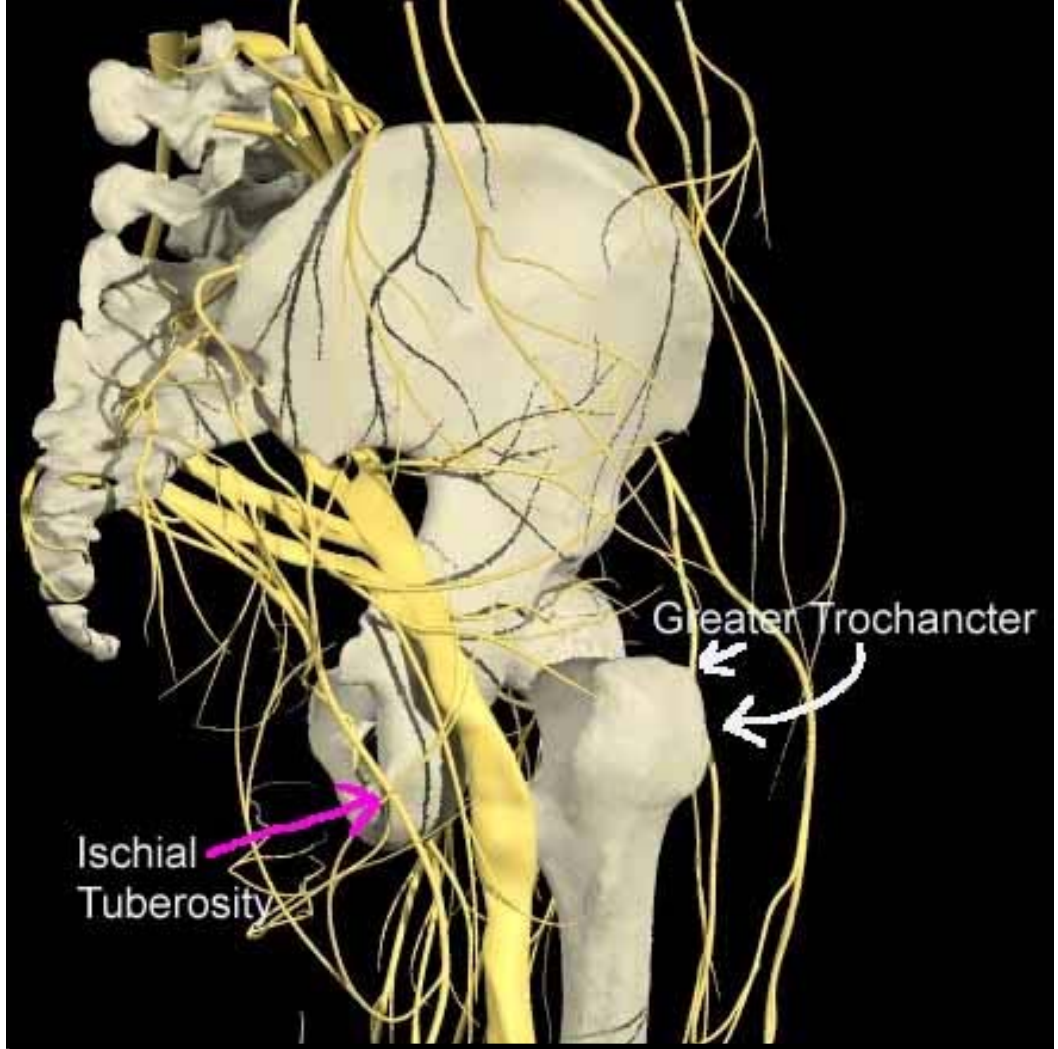




Interactive Hip c 2000 Primal Pictures Ltd.


Short rotator muscles of hip
Piriformis
Superior gemellus
Inferior gemellus
Quadratus femoris
Obturator internus


Superior gluteal nerve
Inferior gluteal nerve
Pudendal nerve
Nerve to obturator internus
Posterior cutaneous nerve of thigh
Sciatic nerve
Tibial branch
Common peroneal branch

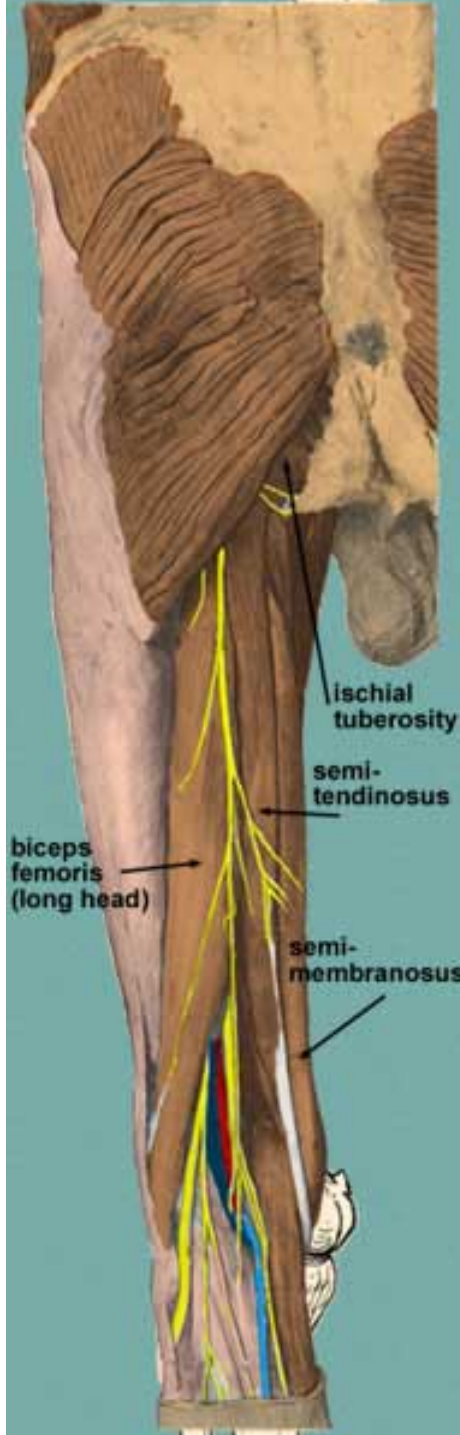


In the gluteal region the nerve lies deep to gluteus maximus, between the Greater Trochanter of the femur and the ischial tuberosity

The sciatic nerve then passes posterior to the adductor magnus and between the **hamstring muscles (posterior compartment muscles),** where the tibial part innervates:

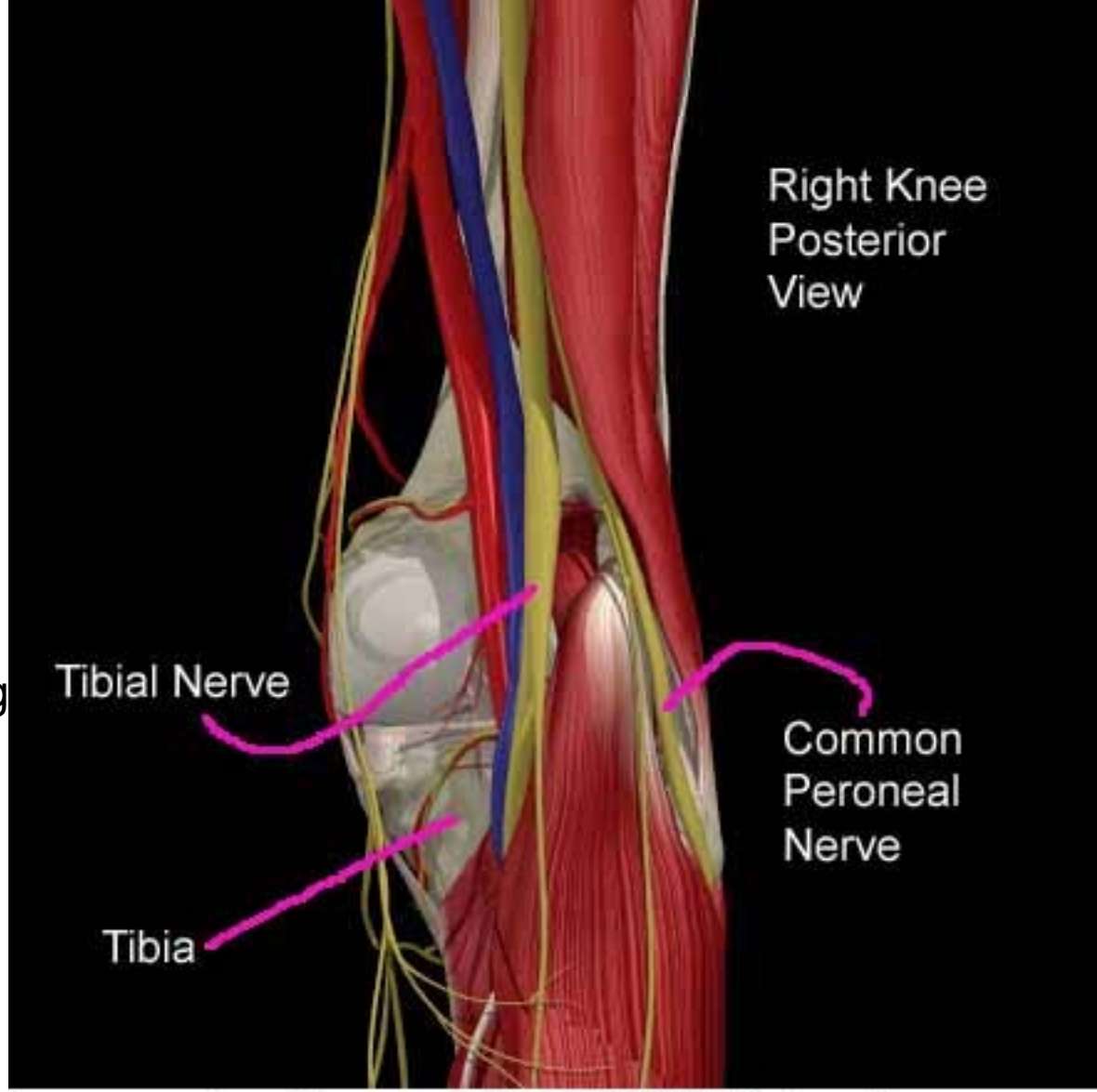
- semitendinosis
- semimembranosis
- biceps femoris (long head

To be called a hamstring, the muscle must arise from the ischial tuberosity.



As the sciatic nerve reaches the posterior knee (popliteal fossa) it physically divides to form the

- **Tibial nerve**
- **Common Peroneal nerve**.
- The Tibial nerve gets its name because it follows the Tibial bone and Common Peroneal due to its soft tissue location at the outer leg region.

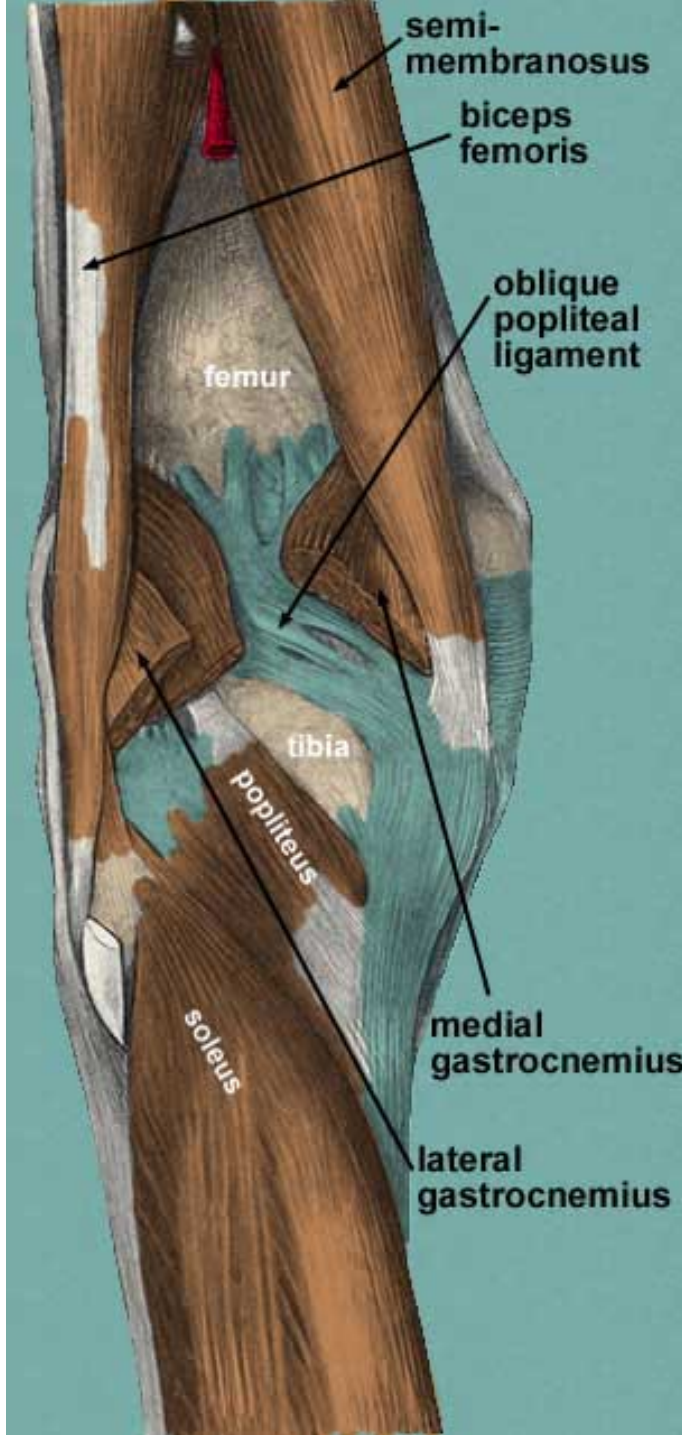


Interactive Knee 1.1 c 2000 Primal Pictures Ltd.

Popliteal Fossa

With the nerves and arteries removed and the muscles reflected, you now identify the structures making up the floor of the popliteal fossa:

- posterior surface of femur
- posterior surface of tibia
- oblique popliteal ligament
- popliteus muscle



Nerves of the Politeal Fossa

The muscles and contents of the popliteal fossa are:

Muscles

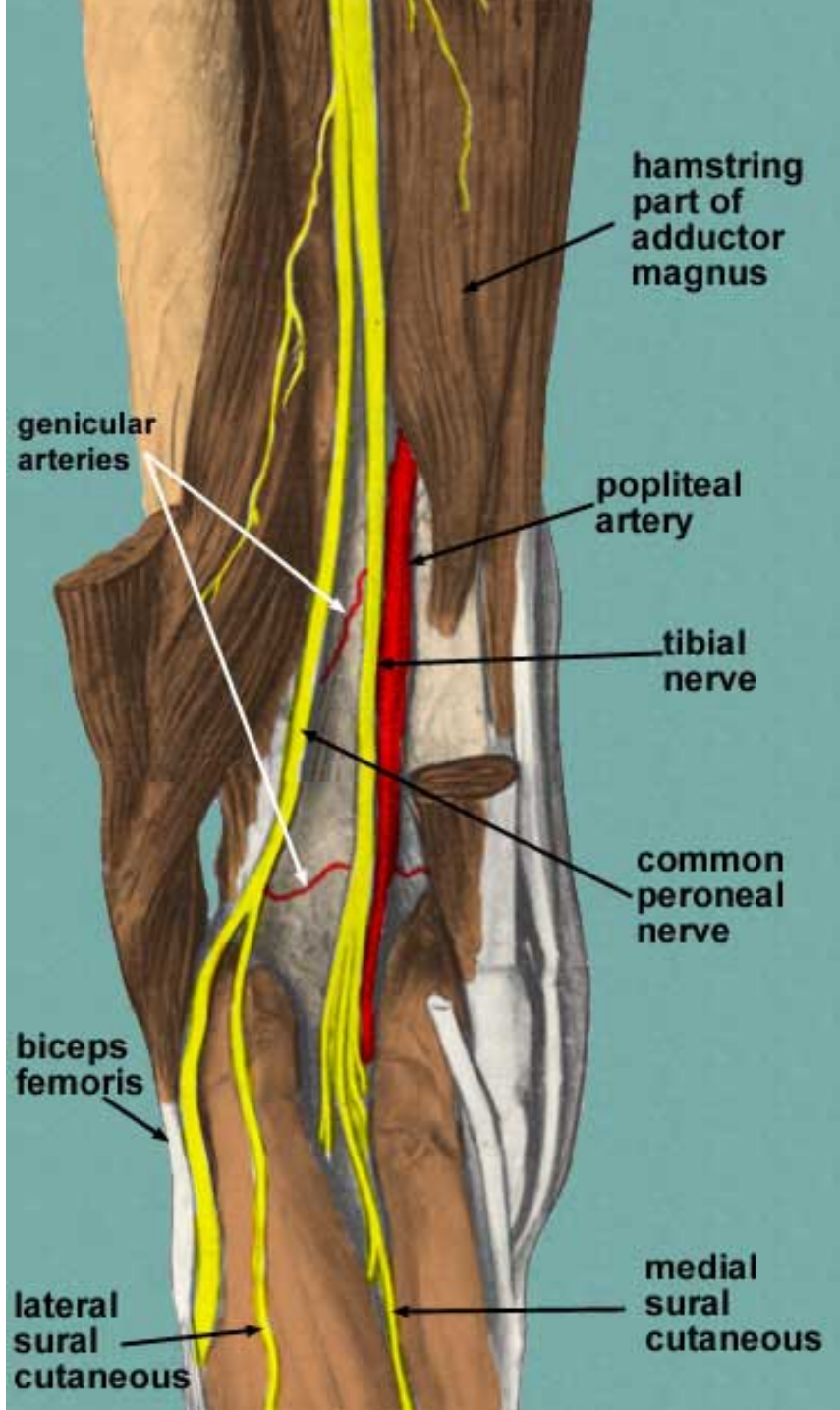
- semitendinosus
- biceps femoris
- medial head of gastrocnemius
- lateral head of gastrocnemius

Arteries

- popliteal artery - continuation of femoral artery
  - superior medial and lateral genicular arteries
  - inferior medial and lateral genicular arteries

Nerves

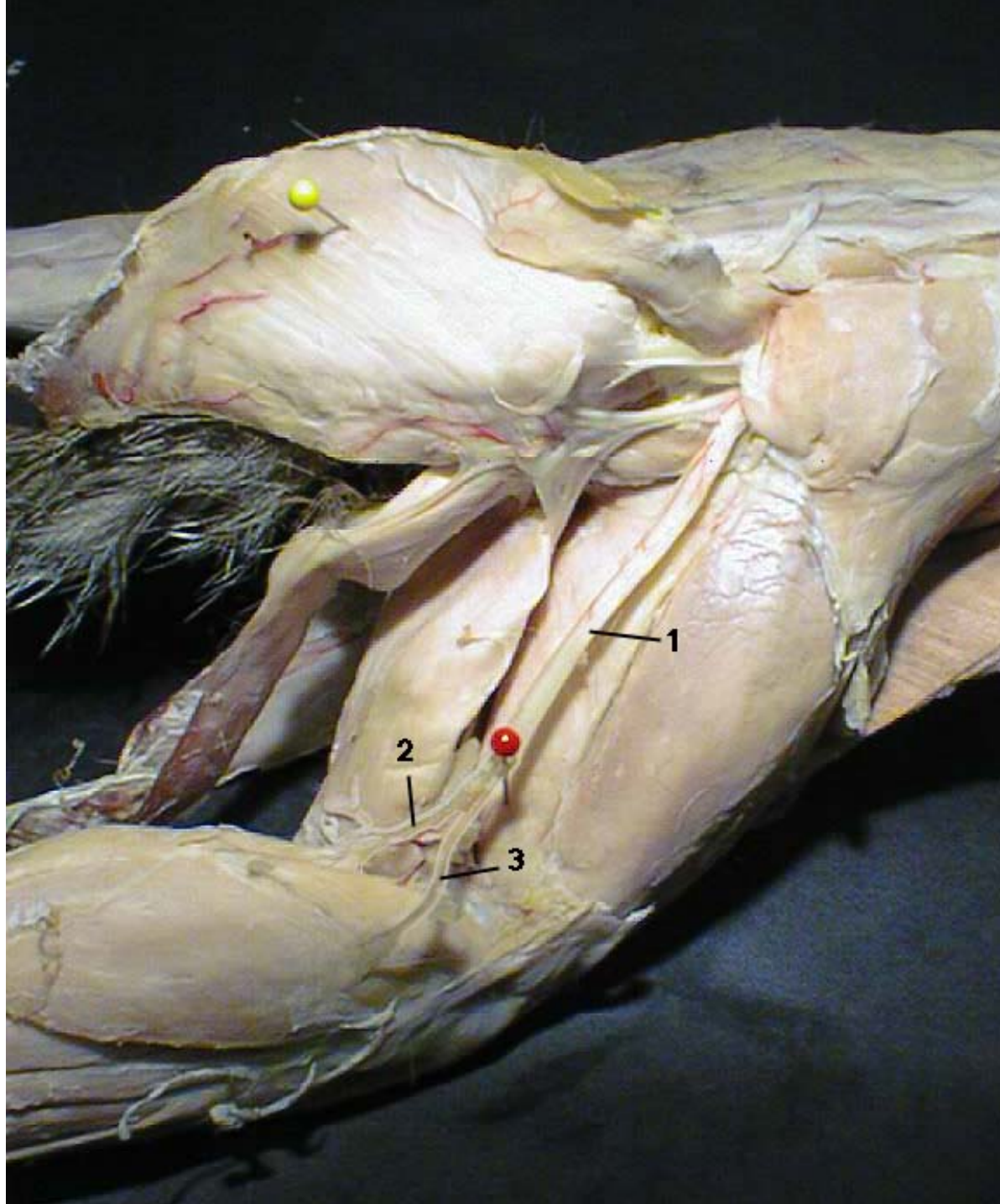
- **tibial nerve**
- **common peroneal nerve**

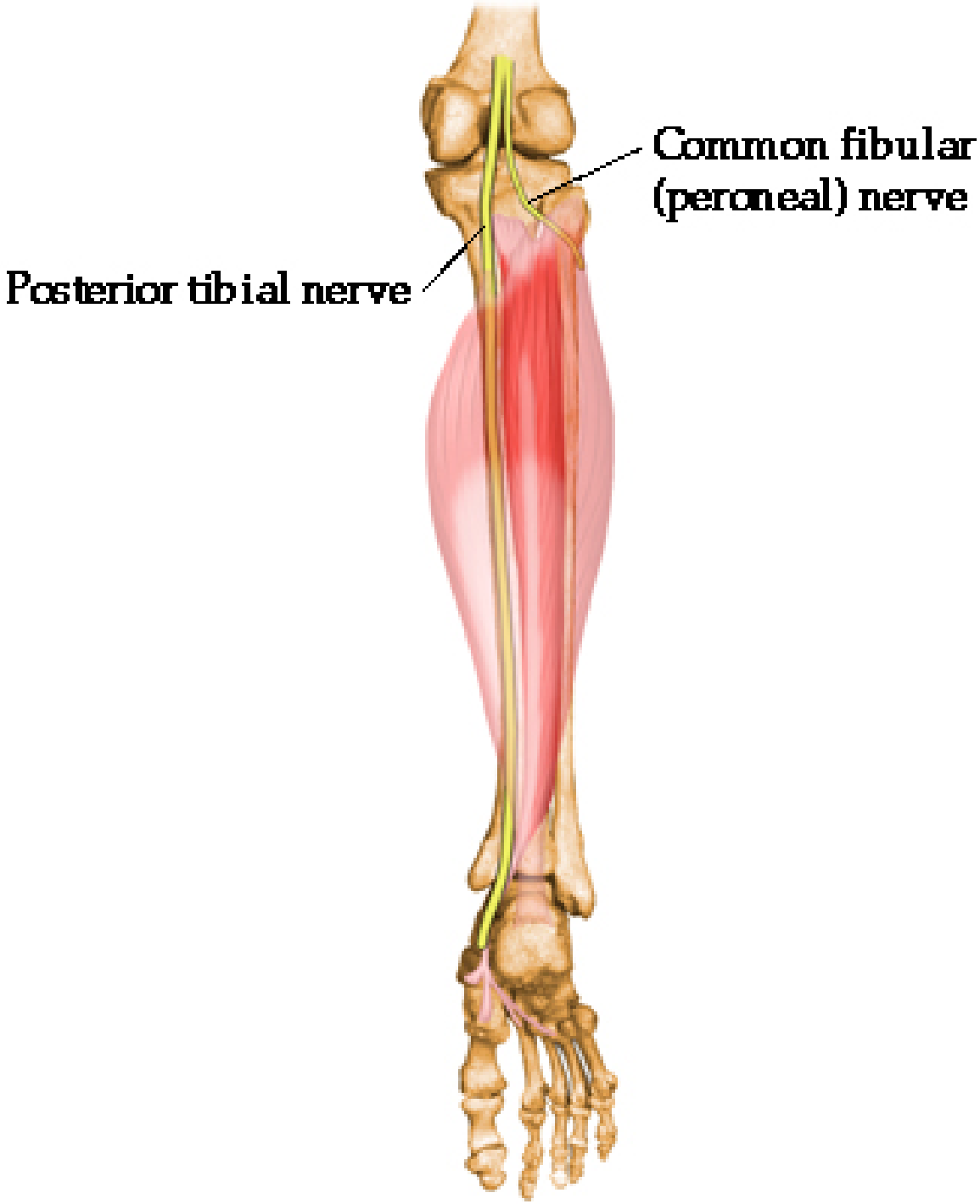


1.Sciatic Nerve

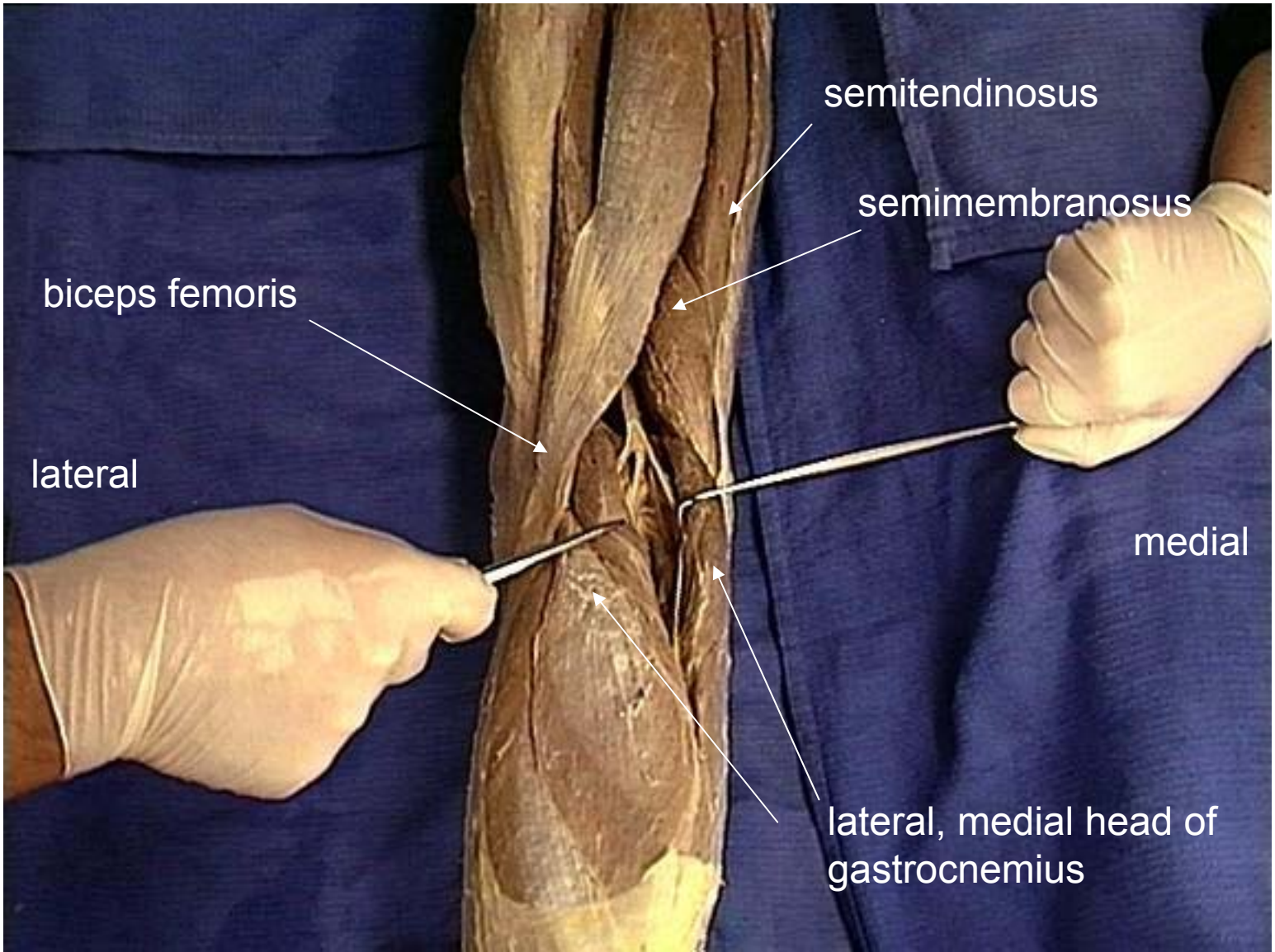
2. Tibial Nerve

3. Common Peroneal nerve (Fibular Nerve)




Common fibular
(peroneal) nerve
Posterior tibial nerve

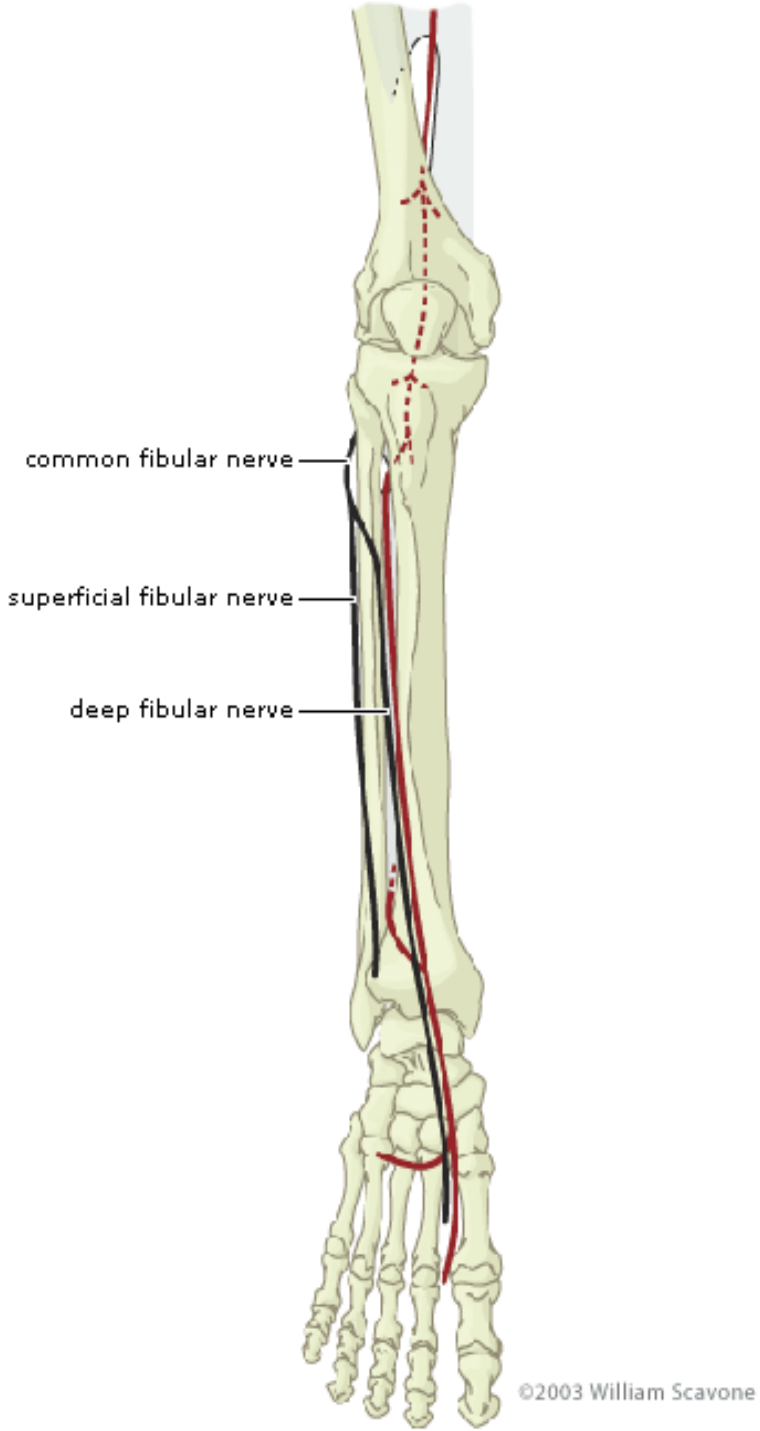
Popliteal Fossa



- **Common peroneal nerve** passes superficial to the neck of the fibula, where it is subcutaneous and vulnerable to injury
- Severence of this nerve causes paralysis of all the muscles of the anterior and lateral compartments (dorsiflexors of the ankle and evertors of the foot). The loss of eversion of the foot and dorsiflexion of the ankle causes **foot-drop**.

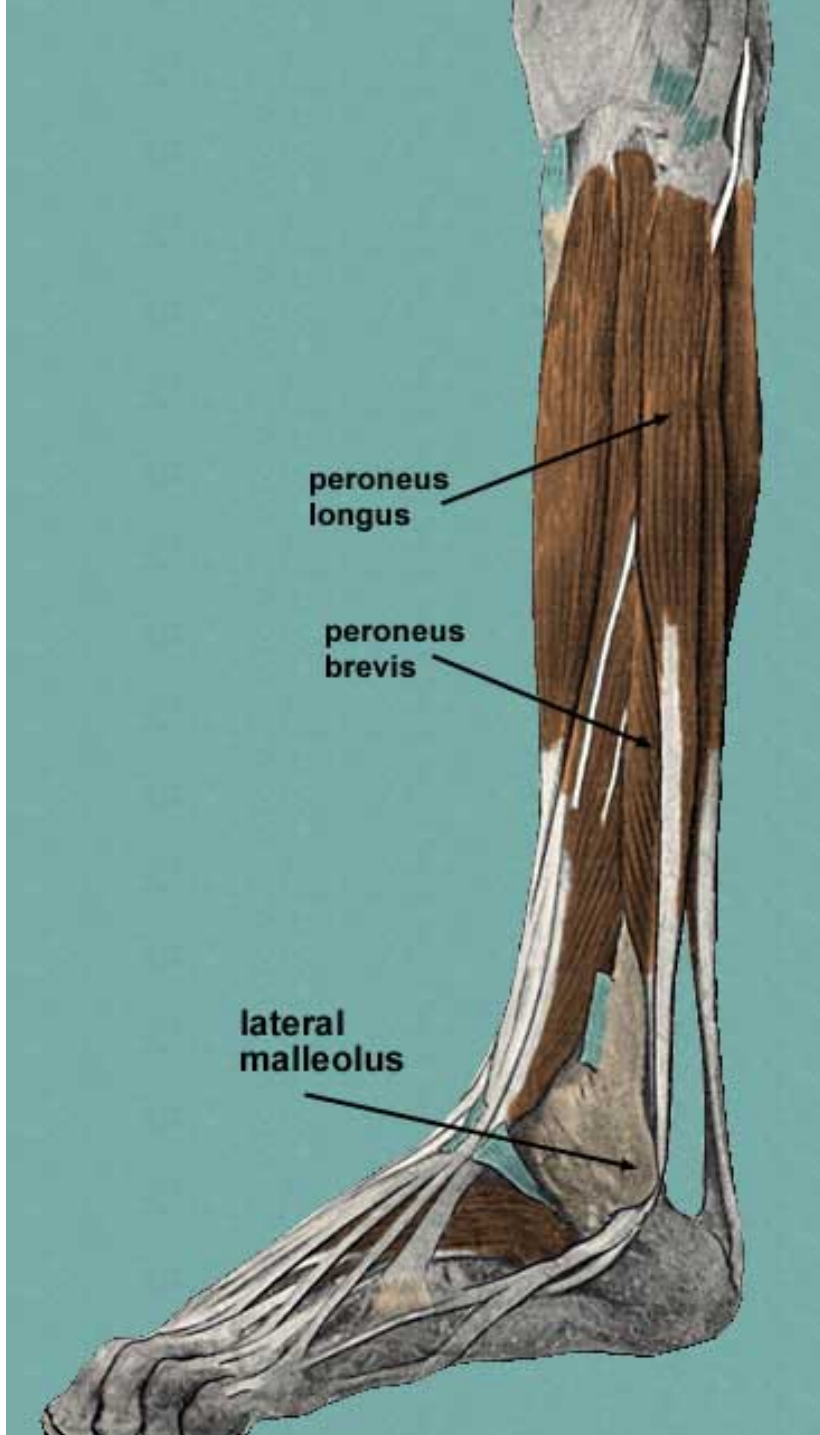
Branches:

- **Superficial peroneal nerve- lateral leg compartment-** peroneus brevis, peroneus longus
- **Deep peroneal nerve**-This is the nerve of the **anterior leg compartment.**
  - Tibialis anterior, Extensor hallucis longus, Extensor digitorum longus, Fibularis (peroneus) tertias
  - Dorsiflexion of foot, extension of toes



Lateral Compartment

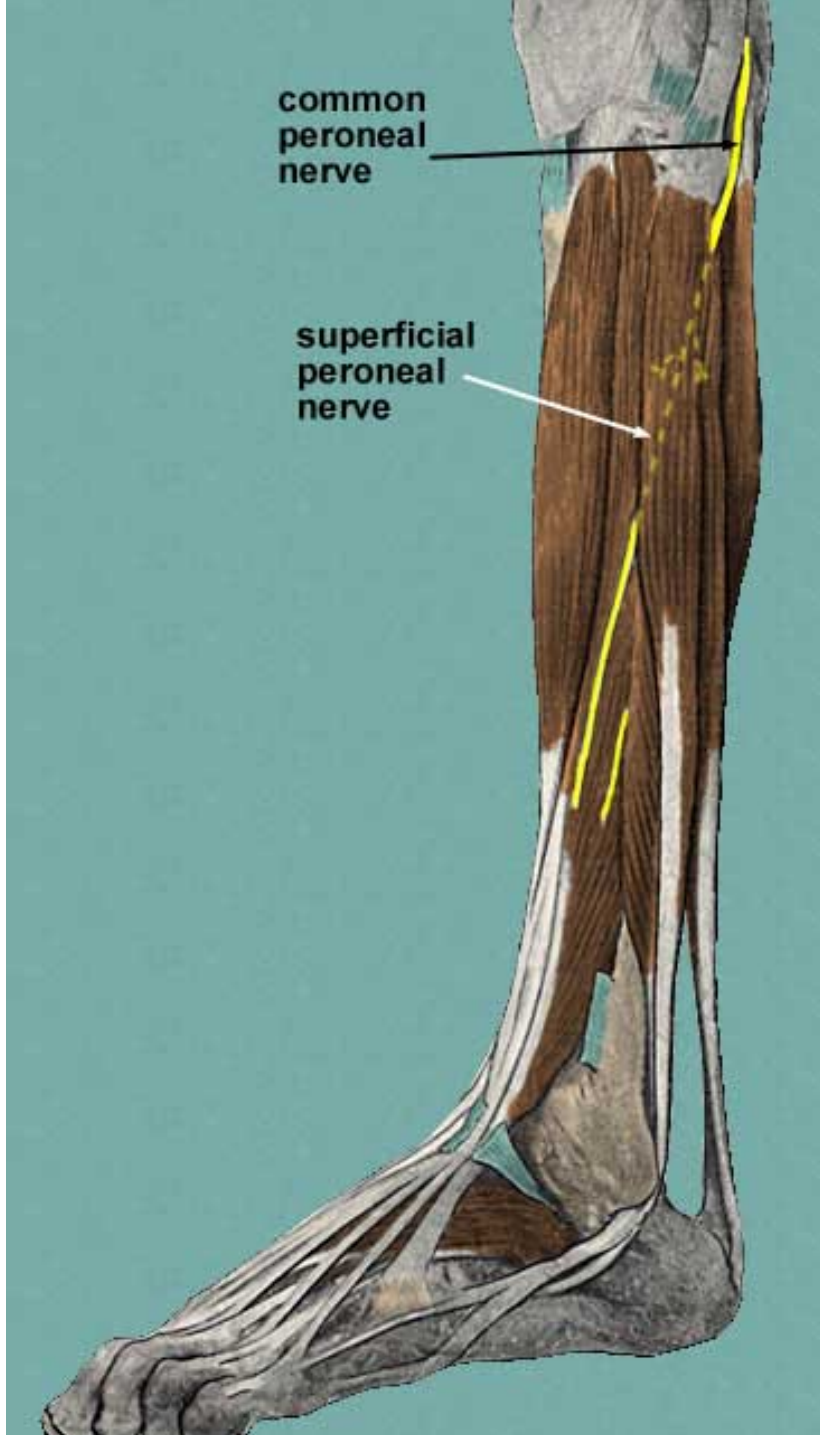
•also called the peroneal compartment
• is made up of two muscles whose tendons cross the ankle joint posterior to and under the lateral malleolus. This makes them flexors of the foot. These muscles are the:
peroneus longus
peroneus brevis



Superficial peroneal Nerve of the Lateral Compartment

The superficial peroneal nerve branches from the common peroneal nerve near the neck of the fibula and passes between the peroneus longus and brevis muscles, at which point they supply the muscles. The superficial branch then continues onto the dorsum of the foot to supply the skin there.

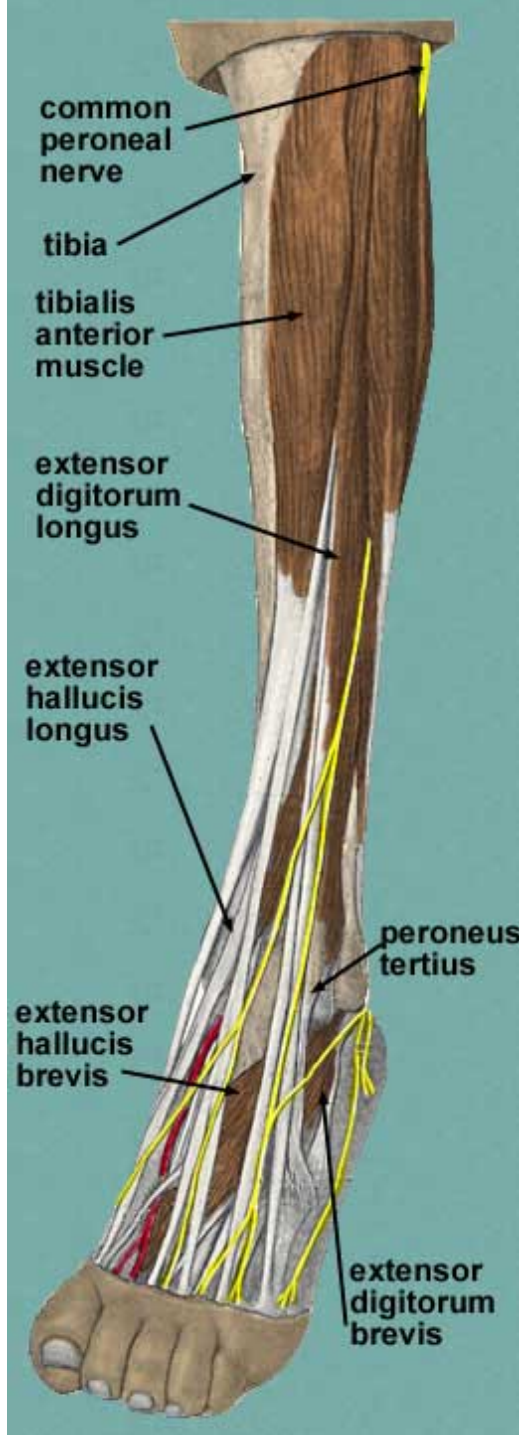
Arteries of the Lateral Leg
The arteries to the tissues in this region are from both the anterior and posterior tibial branches of the popliteal artery.



Anterior Leg Compartment

The anterior compartment contains muscles that are basically extensors of the ankle and toes. They include:

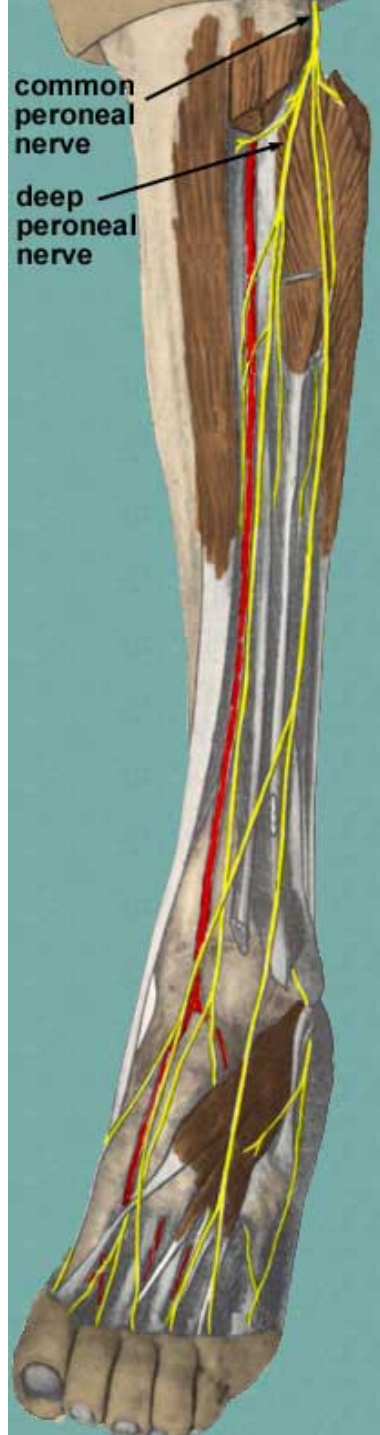
- tibialis anterior
- **extensor digitorum longus**
- **extensor hallucis longus**



Deep Peroneal Nerve of the Anteior Compartment

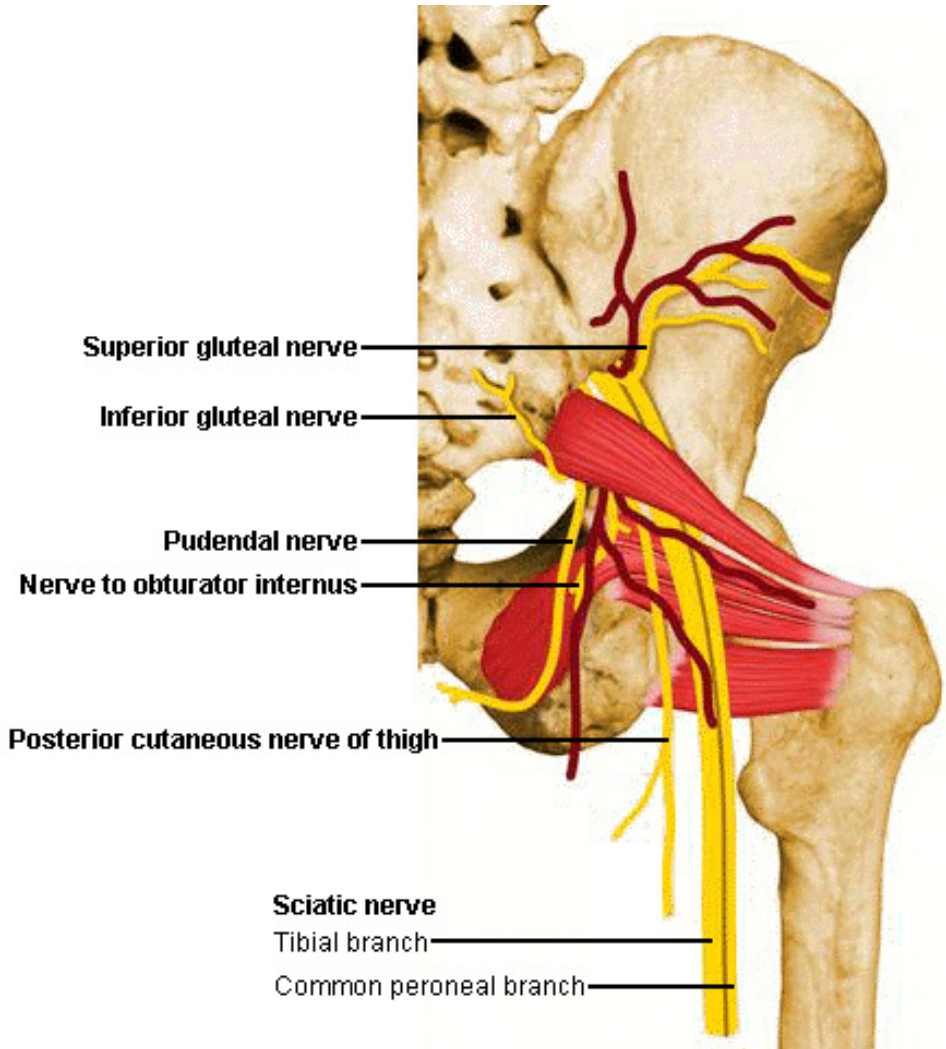
The nerve of the anterior compartment of the leg is the deep peroneal nerve. This nerve terminates between the big toe and second toe and can be tested at this point.

The artery of the anterior compartment of the leg is the anterior tibial artery which is a branch of the popliteal artery. Its terminal branch, the dorsalis pedis, can be palpated on the dorsum of the foot between the 1st and 2nd metatarsal bones.



Other Sacral Nerves:
Internal Pudendal Nerve

S2, S3, S4 join to form the pudendal nerve that supplies structures in the perineum.

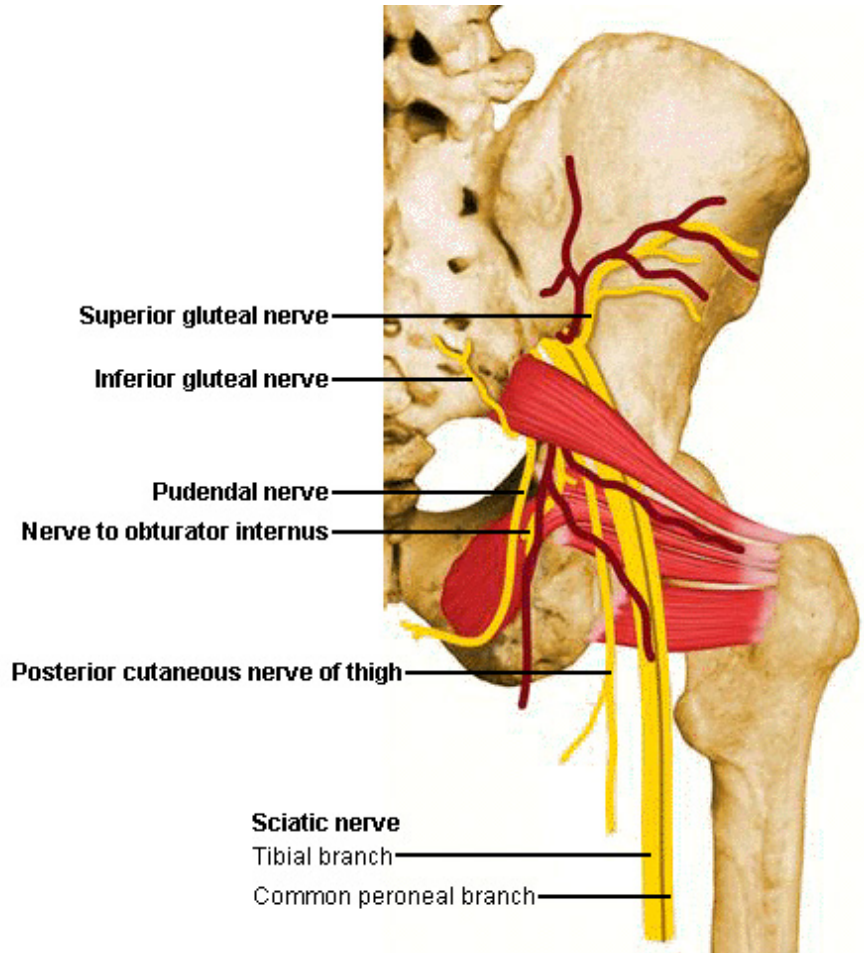


Other Sacral Nerves:
Posterior Cutaneous Femoral Nerve

•arises from the **posterior divisions of the ventral rami of S1 and S2 and the anterior divisions of S2 and S3**.

•It supplies **more skin that any other cutaneous nerve**.

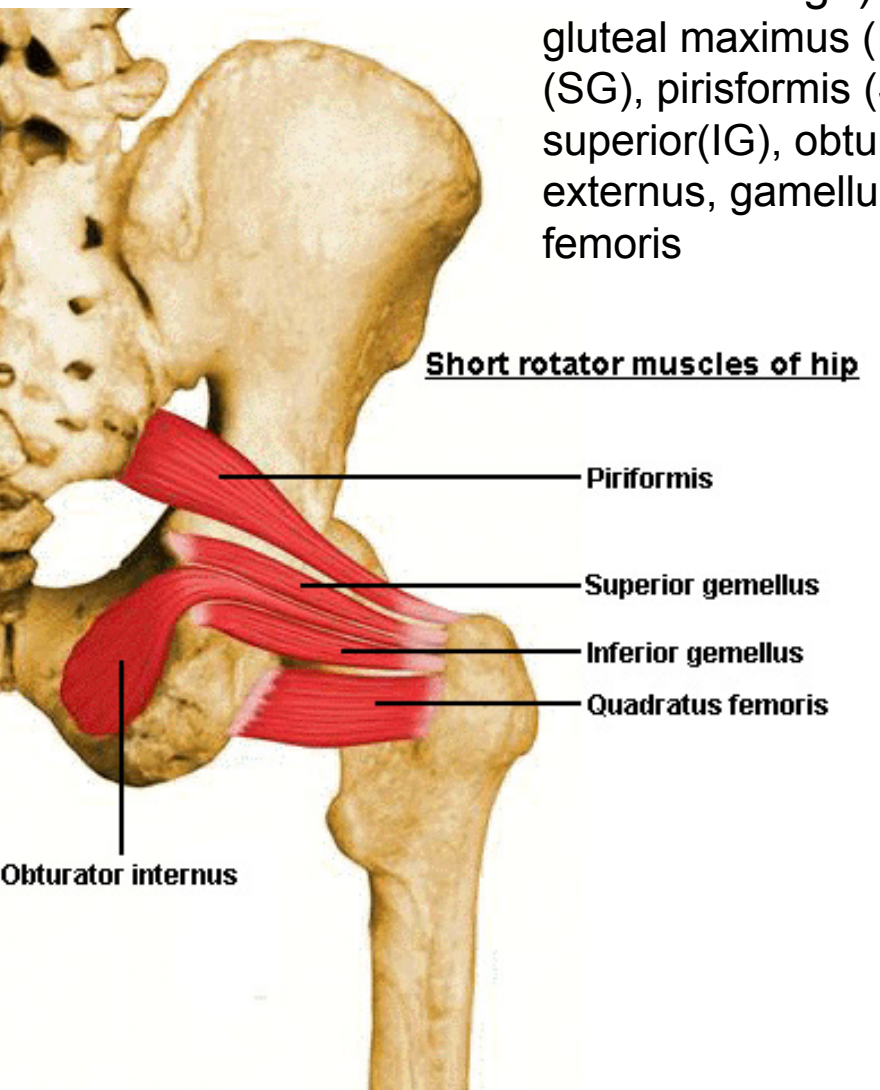
- •skin of the **inferior of the buttock**
- •skin of the **perineum**.
- •posterior thigh and proximal part of the leg.

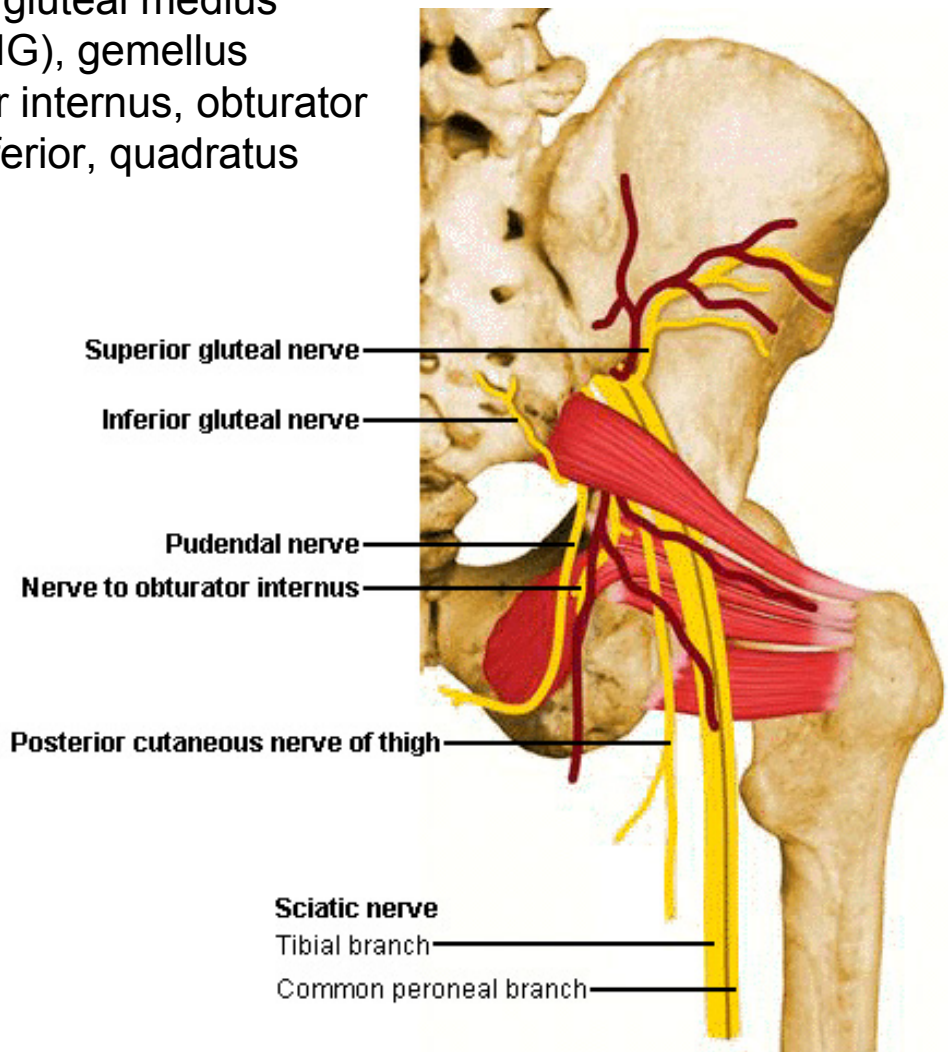


Other Sacral Nerves:

Superior and Inferior Gluteal Nerve

Deep Gluteal Muscles (muscles that move the thigh)- Gluteus minmus (SG), gluteal maximus (IG), gluteal medius (SG), pirisformis (SG,IG), gemellus superior(IG), obturator internus, obturator externus, gamellus inferior, quadratus femoris





Sciatic Nerve; Summary

Originates from L4-S3

Sciatic nerve is comprised of the tibial and common fibular nerves, running in a common epineurium

Landmark: Within the pelvis, the sciatic nerve lies immediately anterior to the piriformis

Landmark: Sciatic nerve emerges from the pelvis via the greater sciatic foramen, usually inferior to the piriformis and deep to the gluteus maximus

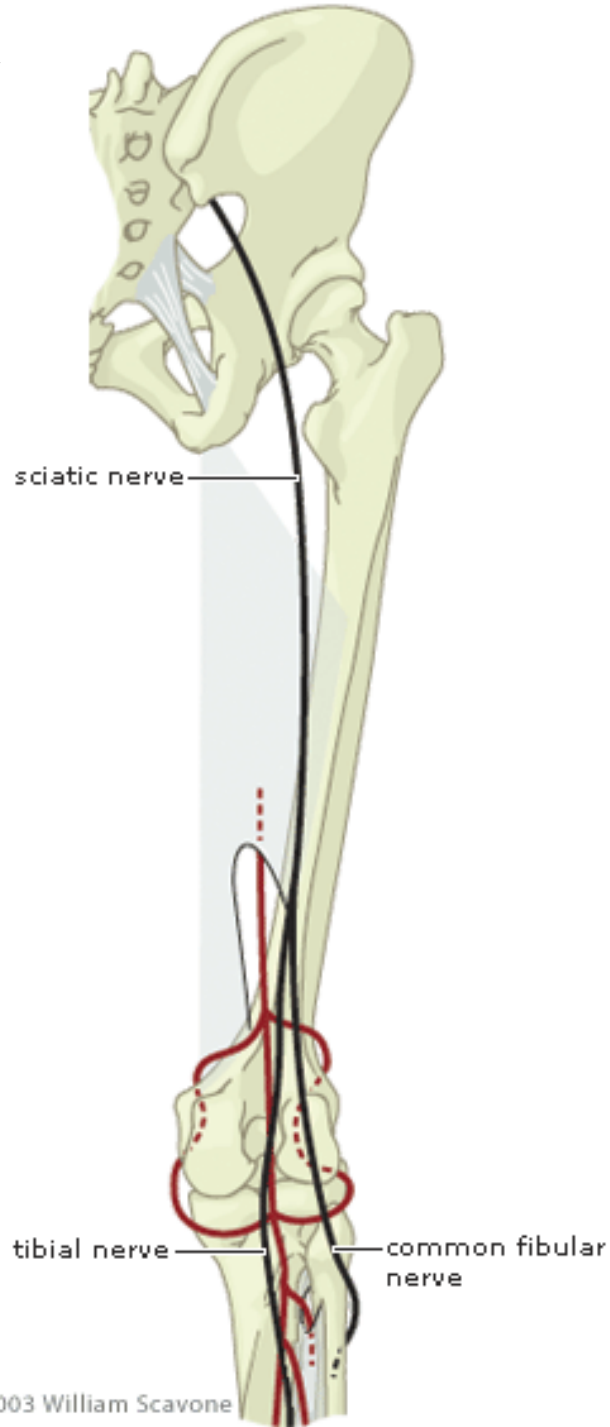
Motor (tibial nerve): Posterior compartment of the thigh

- Exception: short head of biceps femoris is innervated by the common fibular nerve
- Muscles of the posterior compartment of the thigh
- Action: Extend hip, flex knee

Branches: **Tibial nerve** and **common peroneal nerve**

Injury to nerve: Loss of all motor innervation to posterior thigh, anterior and posterior leg, and foot

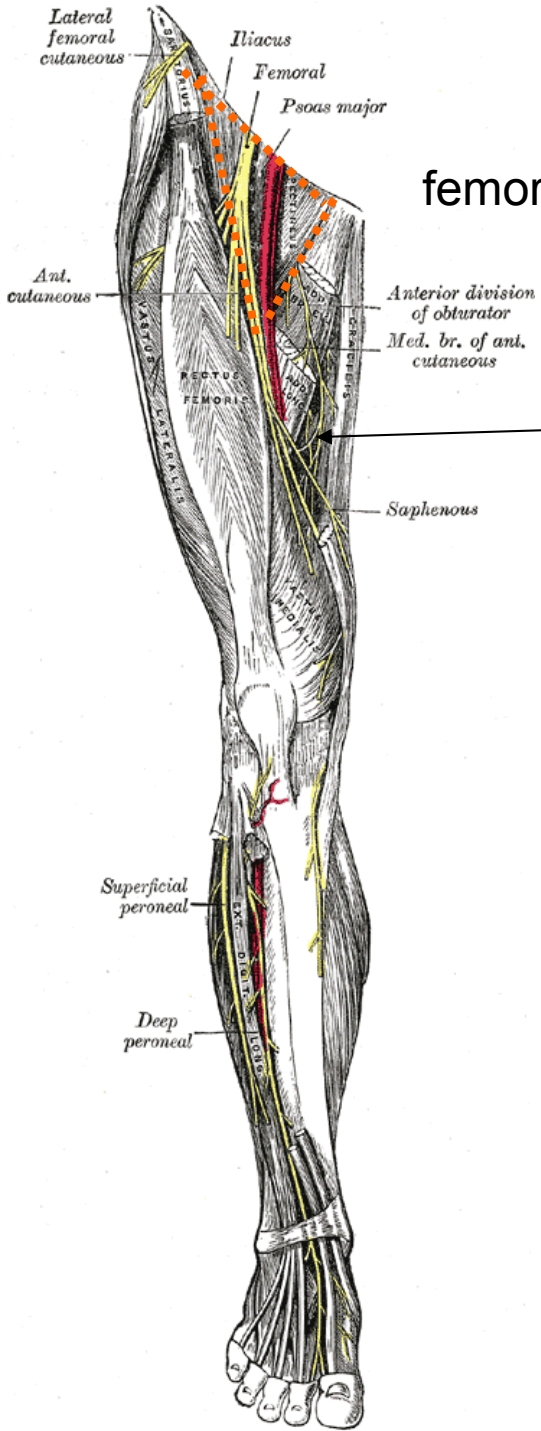
- Clinical features: “Flail foot”



Sciatic Nerve

- largest nerve in the body
- made up of nerve roots from the 4th lumbar vertebra to the 3rd sacral vertebra.

- The **adductor canal** serves as a conduit through which vessels pass from the femoral triangle to the posterior aspect of the knee; **popliteal fossa**
  - femoral artery, vein, and nerve
  - saphenous nerve
  - nerve to vastus medialis



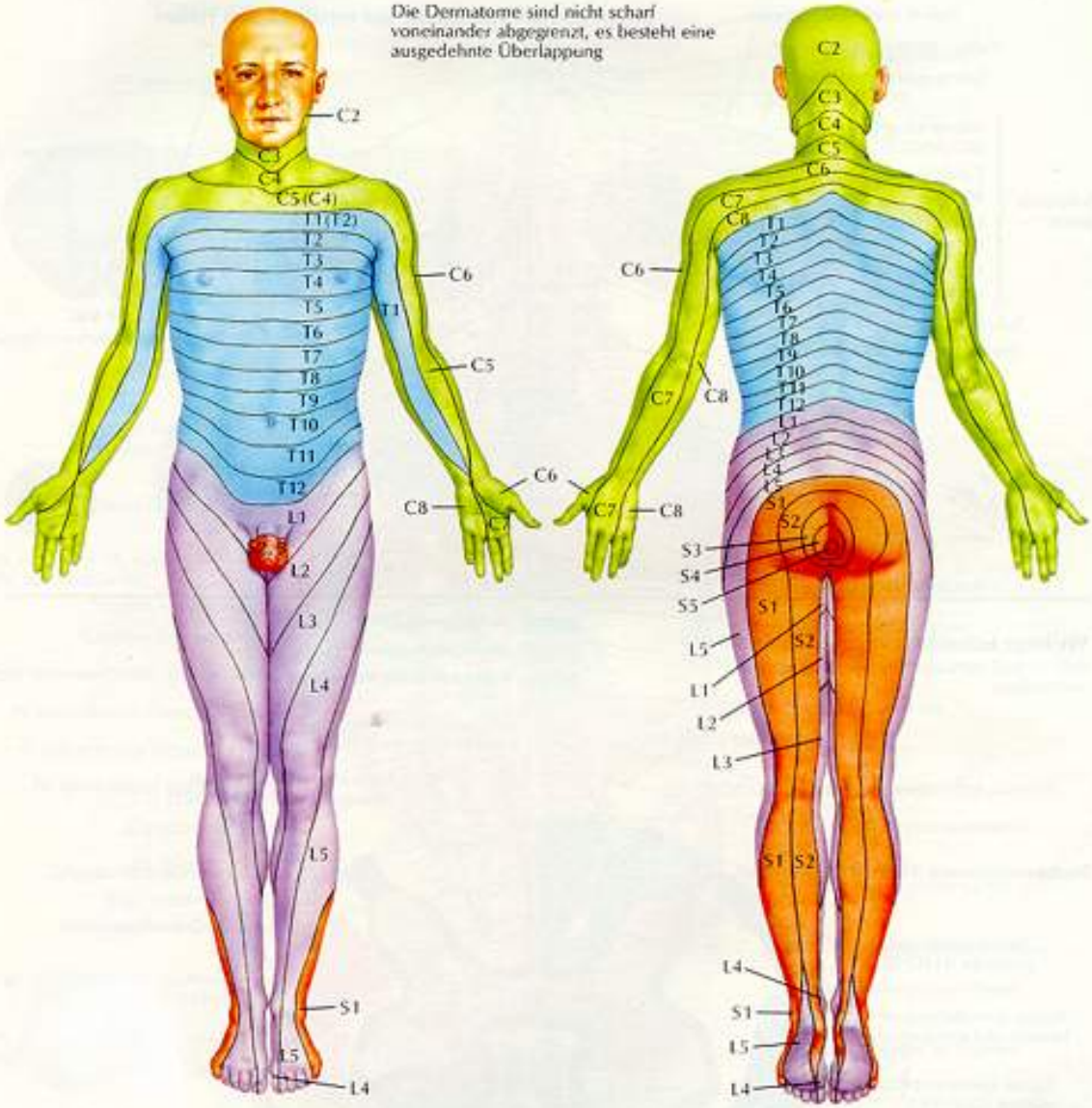
femoral triagule

adductor canal

Cutaneous Innervation and Dermatomes

- each spinal nerve except C1 receives sensory input from a specific area of skin called a **dermatome**
- dermoatomes overlap in their edges by as much as 50%, therefore severance of onw sensory nerve root does not entirely deaden sensation from a dermatome.
- Spinal nerve damage is assessed by testing the dermatomes with pinpricks and noting areas in which the patient has no sensation

Die Dermatome sind nicht scharf voneinander abgegrenzt, es besteht eine ausgedehnte Überlappung



Anordnung der Dermatome

C 5 (C 4)	Höhe der Clavicula
C 5, 6, 7	Laterale Seite des Armes
C 8, T 1	Mediale Seite des Armes
C 6	Daumen
C 6, 7, 8	Hand
C 8	4. und 5. Finger
T 4	Höhe der Mamilla
T 10	Nabelhöhe
T 12	Leistengegend
L 1, 2, 3, 4	Vorder- und Innenfläche des Beines
L 4, 5, S 1	Fuß
L 4	Mediale Fußkante
S 1, 2, L 5	Hinter- und Außenfläche des Beines
S 1	Laterale Fußkante
S 2, 3, 4	Anogenital-Bereich

Somatic Reflexes

- Reflexes are quick, involuntary, stereotyped reactions tf glands or muscles to stimulation
- Four important properties of reflexes
  - reflexes require stimulation- they are not spontaneous
  - reflexes are quick- involve few if any interneurons and miminum synaptic delay
  - reflexes are involuntary- they occur without intent, or awareness, and are difficult to suppress
  - reflexes are stereotyped- they occur in essentially the same way every time.

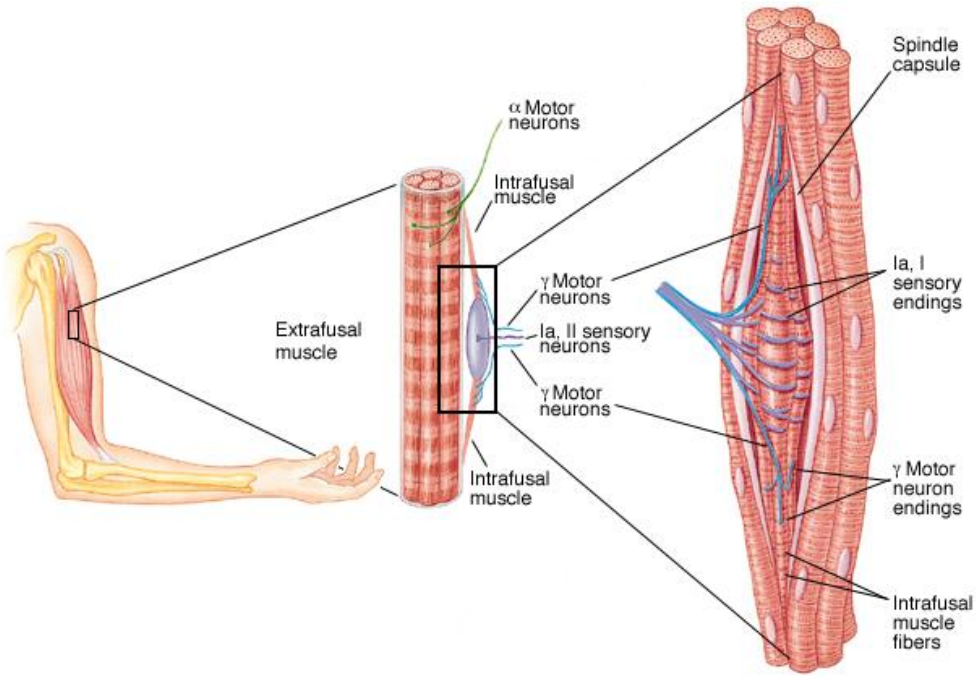
Somatic Reflexes

Somatic reflex employ a **reflex arc**

- **somatic receptors** in the skin, muscle or a tendon
- **afferent nerve fibers-** carry information from receptors into the dorsal horn of the cord
- **interneurons**- integrate information (lacking in some reflexes)
- **efferent nerve fibers-** carry motor impulses to the skeletal muscle
- **skeletal muscle-** the somatic effectors that carry out the response

Muscle Spindle

- are stretch receptors in the muscle
  - a type of **proprioceptor**-sense organs that monitor the position and movements of body parts
- more abundant in muscles that require fine control



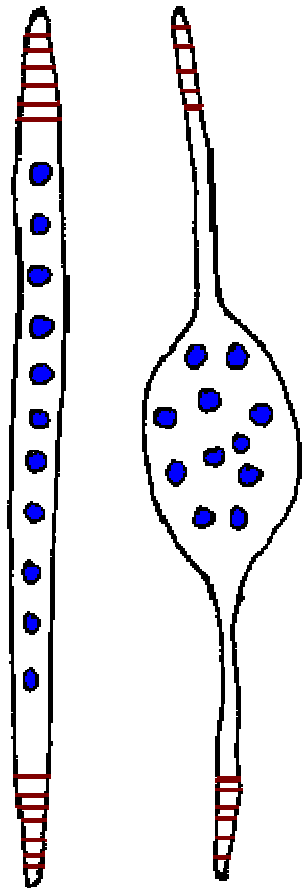
Muscle Spindle

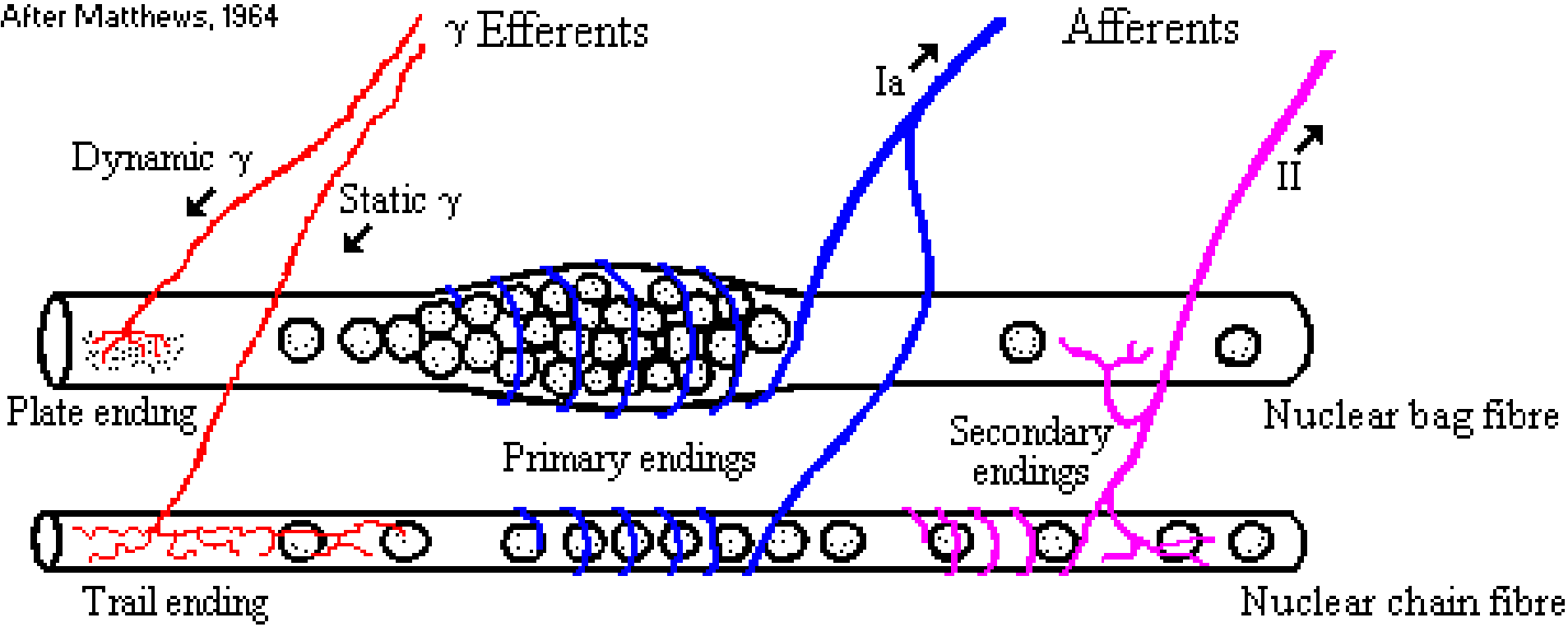
- consist of modified muscle fibers (**intrafusal fibers** to distinguish them from **extrafusal fibers**, i.e. the rest of the muscle)
- only the two ends of an intrafusal fiber have sarcomeres and are able to contract
- middle portion acts as a stretch receptor

Muscle Spindle

Two types of intrafusal muscle fibers based anatomically on the location of their nuclei

- **Nuclear bag-** the nuclei hang out in the center of the fiber, which bulges out into a bag.
- **Nuclear chain-** the nuclei spread out along the fiber like a chain.
- only the ends of the intrafusal fibers contain sarcomeres and are able to contract



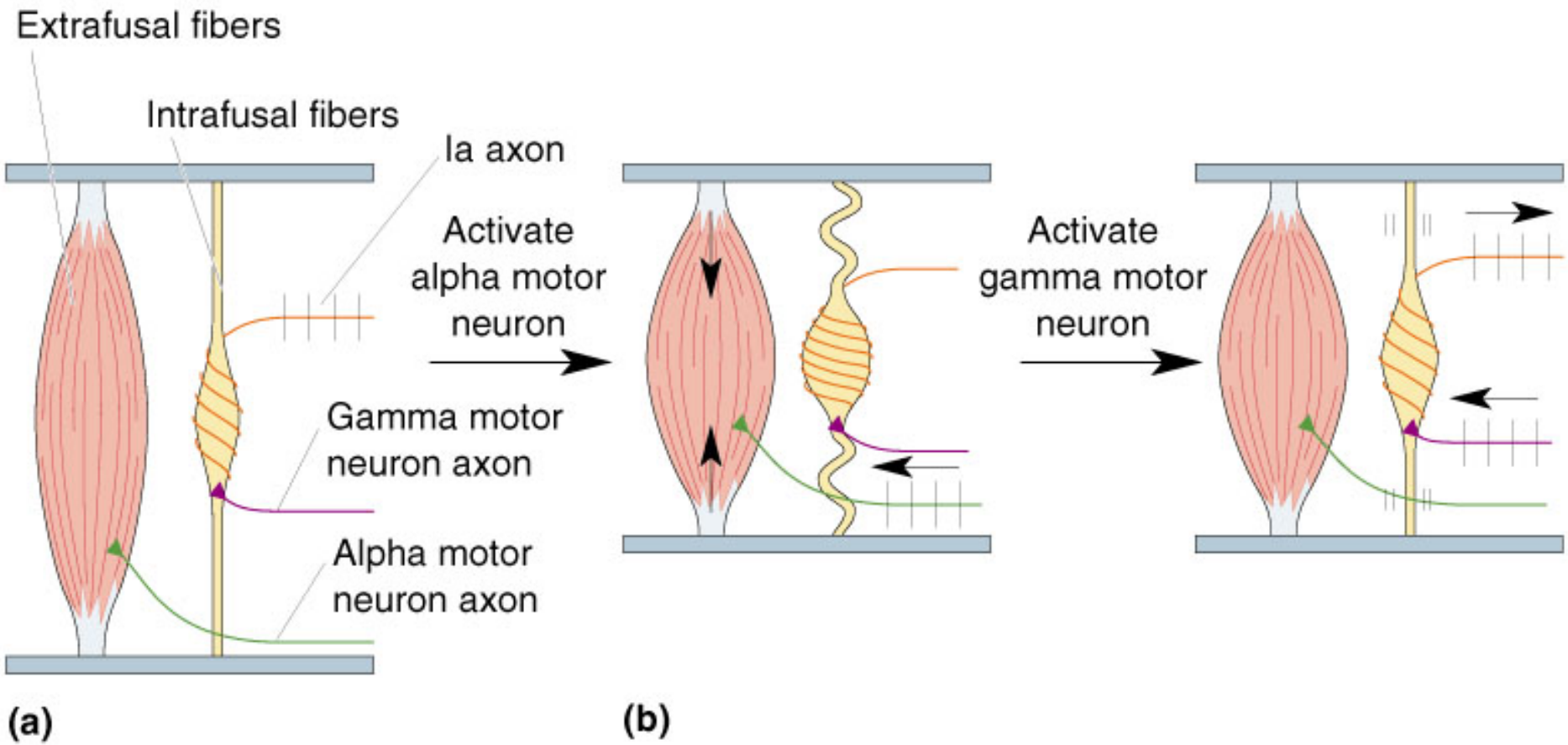


Have three types of nerve fibers

- Both contain **primary afferent nerve fibers (Ia)** which end in annulospiral fibers that coil around middle that **respond** mainly **to muscle stretch**
- **secondary afferent nerve fibers** wrap primarily around the ends of nuclear chain fibers that respond mainly to prolonged strecth
- **gamma motor neurons fibers** which innervate the ends of the intrafusal fibers (constitutes about 1/3 of fibers in a spinal nerve)

Adjustment of Length of intrafusal fibers by Gamma fibers

Figure 13.19
The function of gamma motor neurons. (a) Activation of alpha motor neurons shortens the extrafusal muscle fibers. If the muscle spindle becomes slack, it goes "off the air" and no longer reports the length of the muscle. (b) Activation of gamma motor neurons contracts the poles of the spindle, keeping it "on the air."



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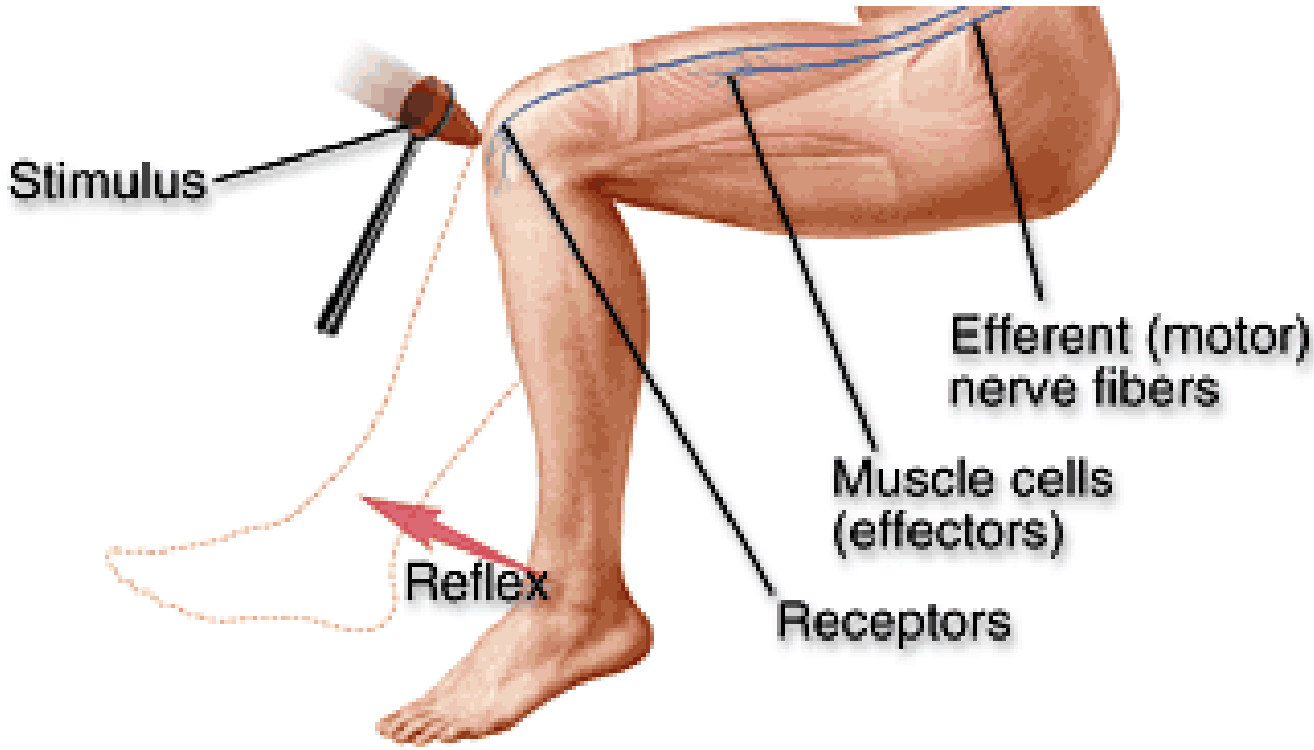
Stretch Reflex

- **Stretch (myotatic) reflex-** When a muscle is stretched, it “fights back”- it contracts, maintains increased tonus, and feels stiffer than when unstretched.
- often feeds back to a set of synergists and antagonist muscles thereby
  - stabilizing joints by balancing the tension of the extensors and flexors
  - dampen (smooth) muscle action
- **reciprocal inhibition-** prevents muscles from working against each other by inhibiting antagonist

Stretch Reflex

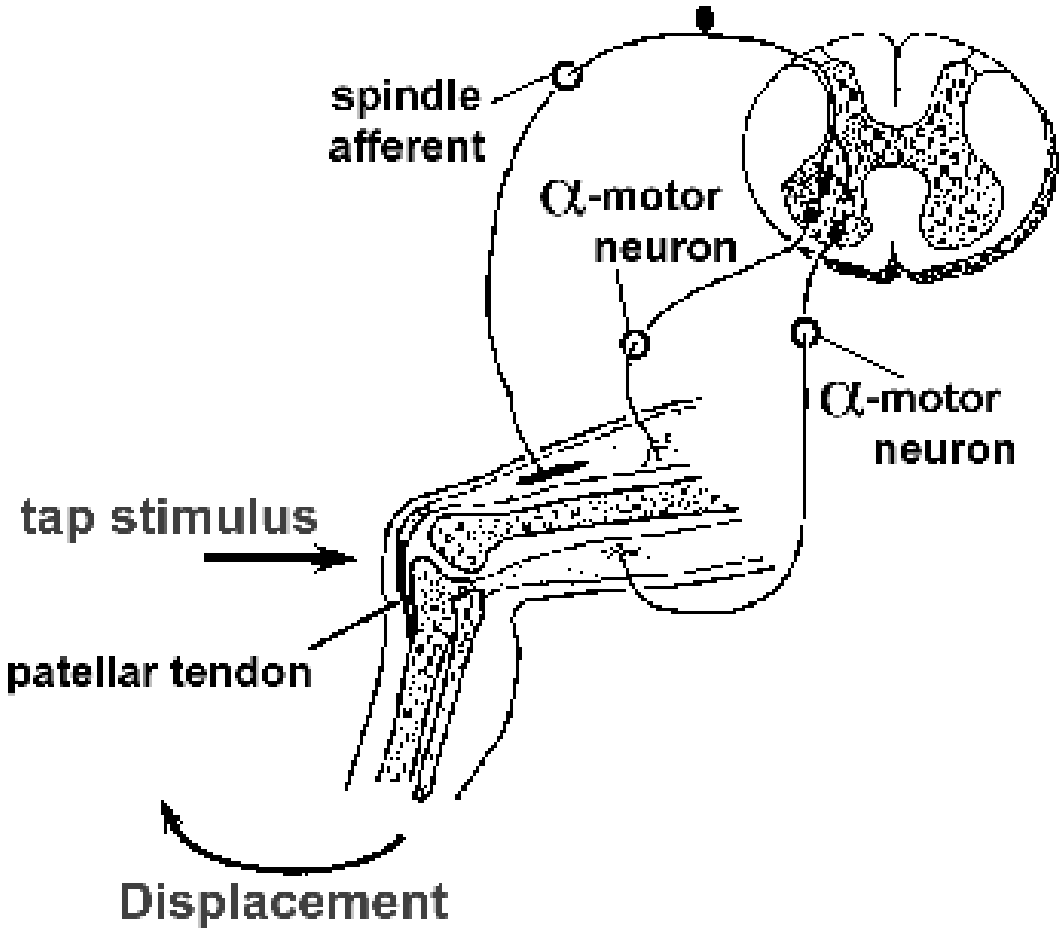
- stretch reflex is mediated primarily by the brain, therefore, is not strictly a spinal reflex
- a weak component of the spinal reflex is spinal and occurs even if the spinal cord is severed from the brain.
- the spinal component can be more pronounced if a muscle is stretched very suddenly and is the bases of the **tendon reflex**
  - ex. knee-jerk (patellar) reflex

Patellar Reflex



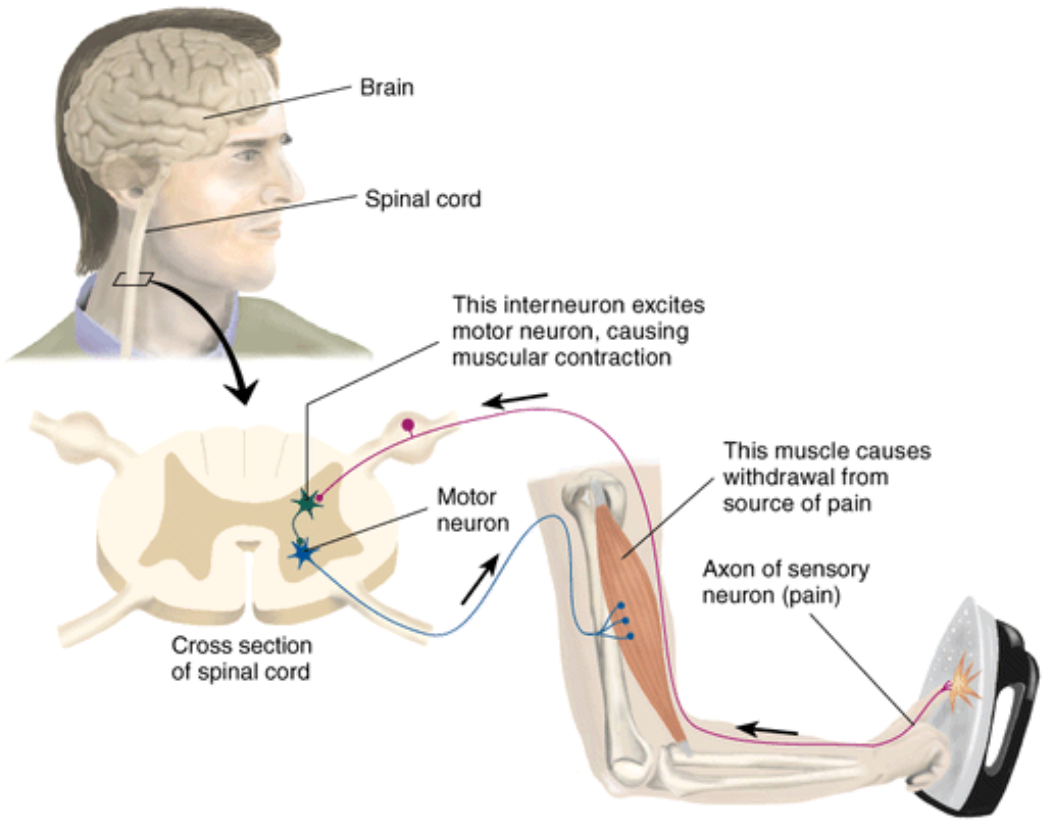
- tapping the patellar ligament suddenly stretches the quadriceps femoris. This stimulates numerous muscle spindles in the quads and sends and intense volley of signals to the spinal cord.

Stretch Reflex



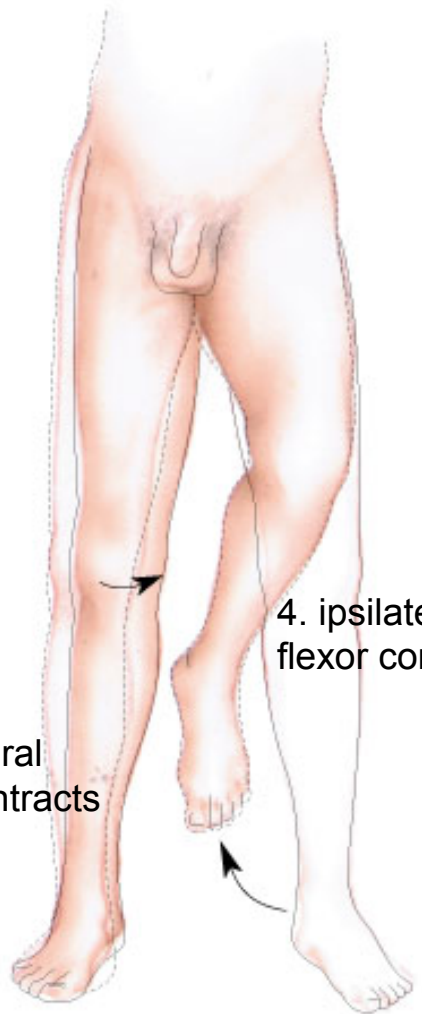
- tendon reflex is a **monosynaptic reflex arc-** only one synapse between the afferent and efferent neuron, therefore there is little synaptic delay and very prompt response
- occurs in 50 milliseconds, too fast for brain to be involved

Withdrawal Reflex


Brain
Spinal cord
This interneuron excites motor neuron, causing muscular contraction
This muscle causes withdrawal from source of pain
Motor neuron
Axon of sensory neuron (pain)
Cross section of spinal cord

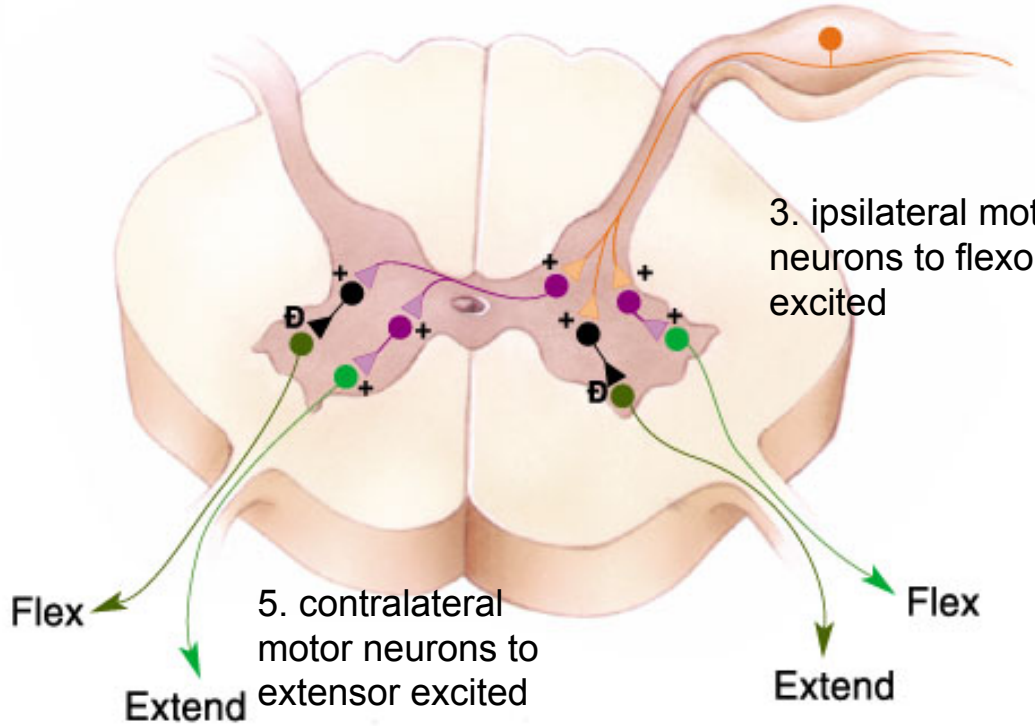
- a more complex act involving a **polysynaptic reflex arc** with more synapses

Flexor and Crossed Extensor Reflex



1. stepping on glass stimulates pain receptors in left foot

2. sensory neuron activates multiple interneurons



3. ipsilateral motor neurons to flexor excited

4. ipsilateral flexor contracts

5. contralateral motor neurons to extensor excited

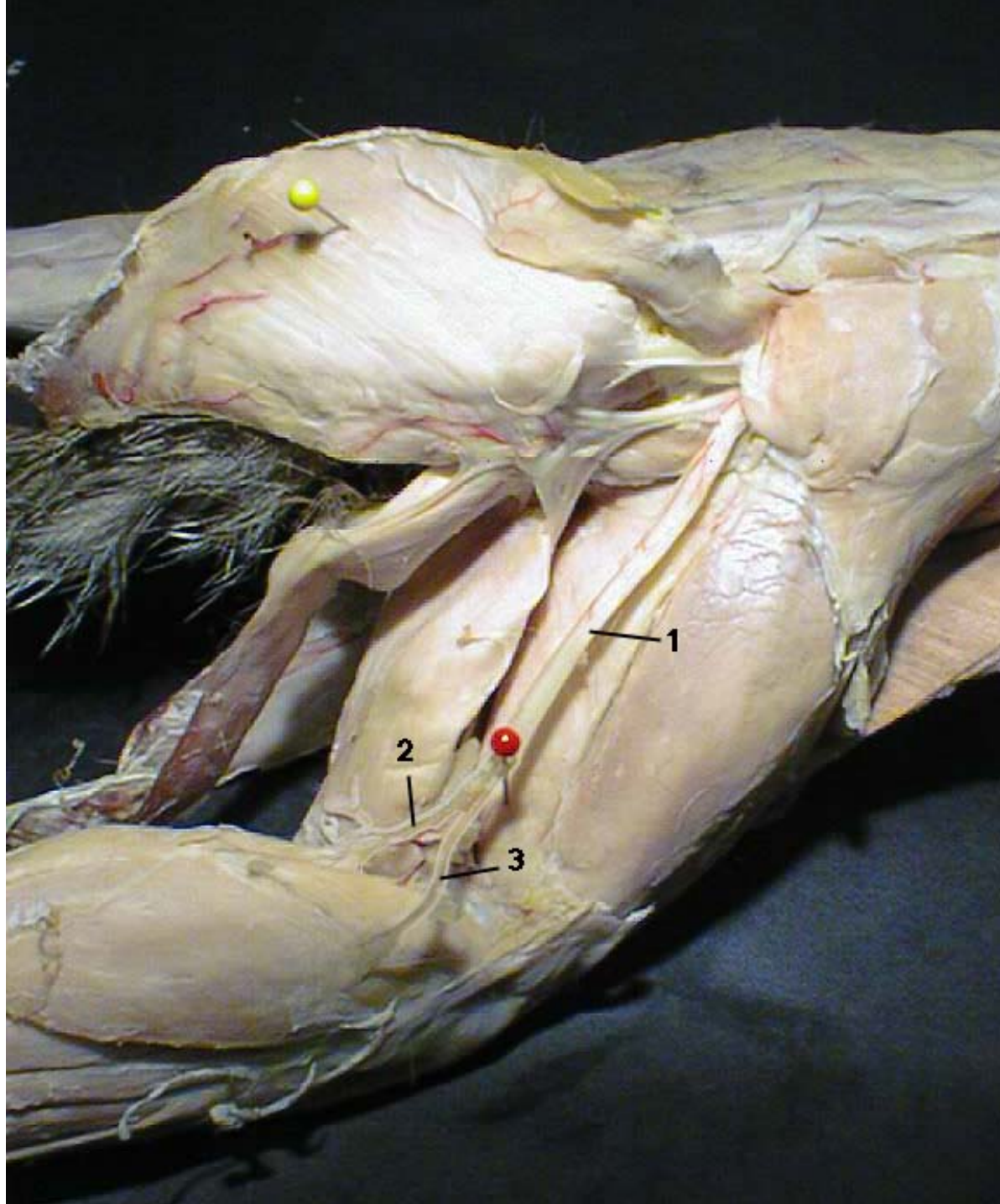
6. contralateral extensor contracts

- **Golgi tendon organ** - stretch receptors located within the tendons, detecting the amount of stretch exerted by the muscles on the bones to which they are attached; encode degree of stretch by the rate of firing; don't respond to length, but to how hard it is pulling
- synapse onto an interneuron in the spinal cord gray matter which then synapse onto the relevant alpha motor neuron, producing inhibitory (glycine) potentials
  - decreases muscular contraction, prevents injury

1.Sciatic Nerve

2. Tibial Nerve

3. Fibular Nerve

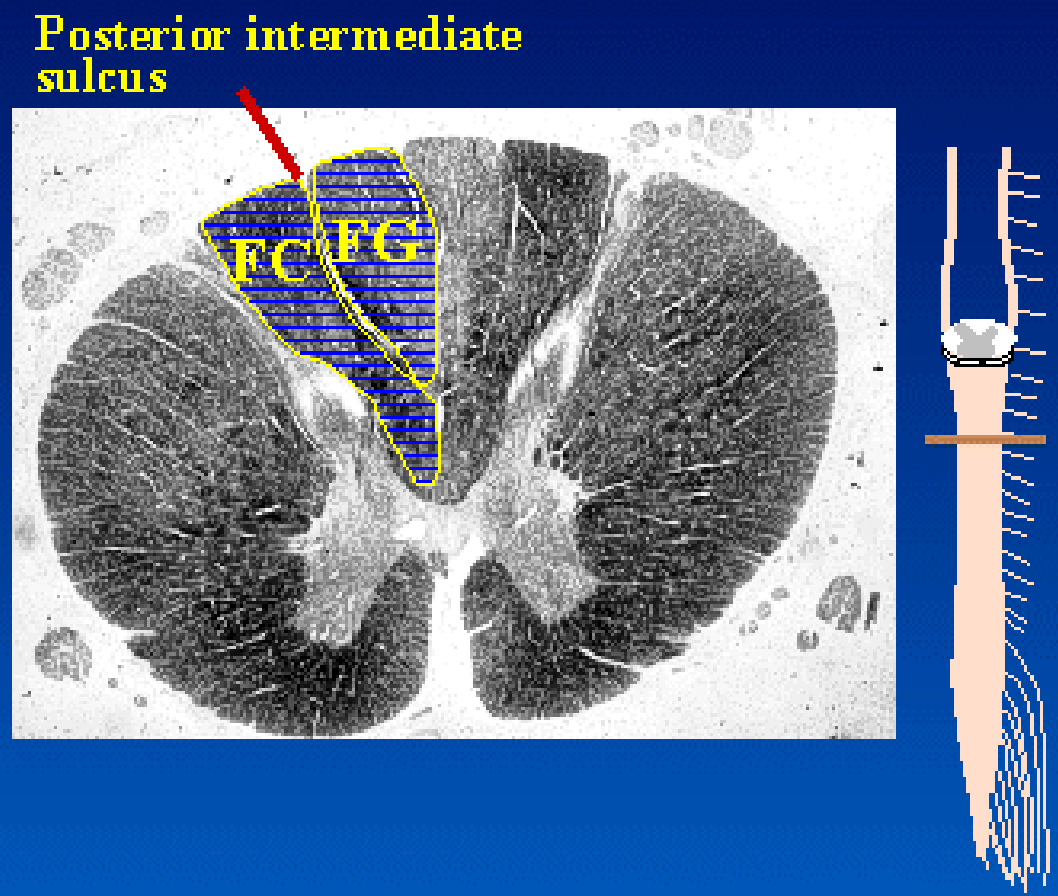


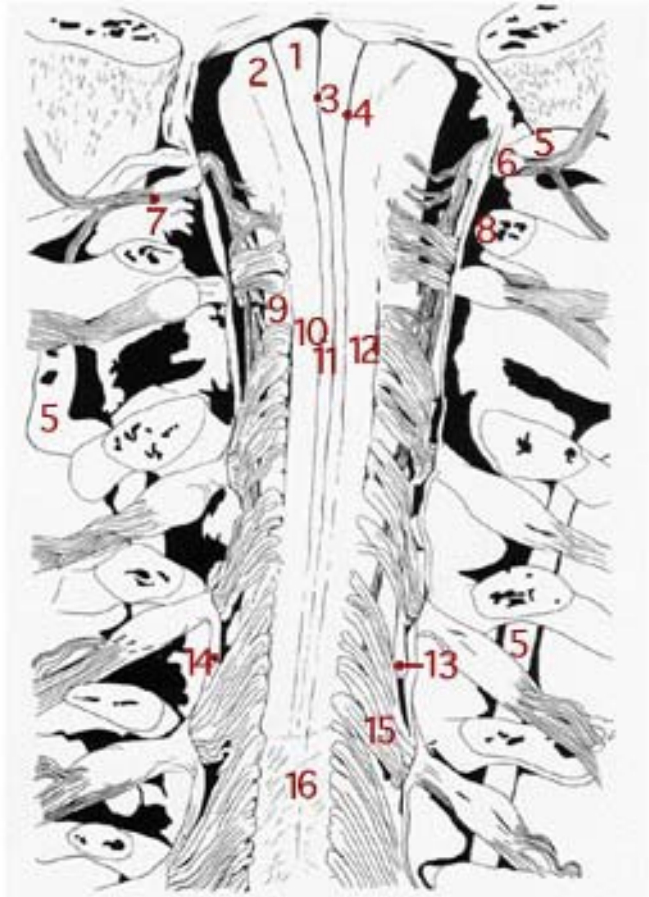
Upper Thoracic Segment - T (T2)

White Matter continued

In spinal cord segments C1 thru T6, the posterior funiculus is subdivided into the the fasciculus gracilis (FG) and fasciculus cuneatus (FC) by the posterior intermediate sulcus and septum.

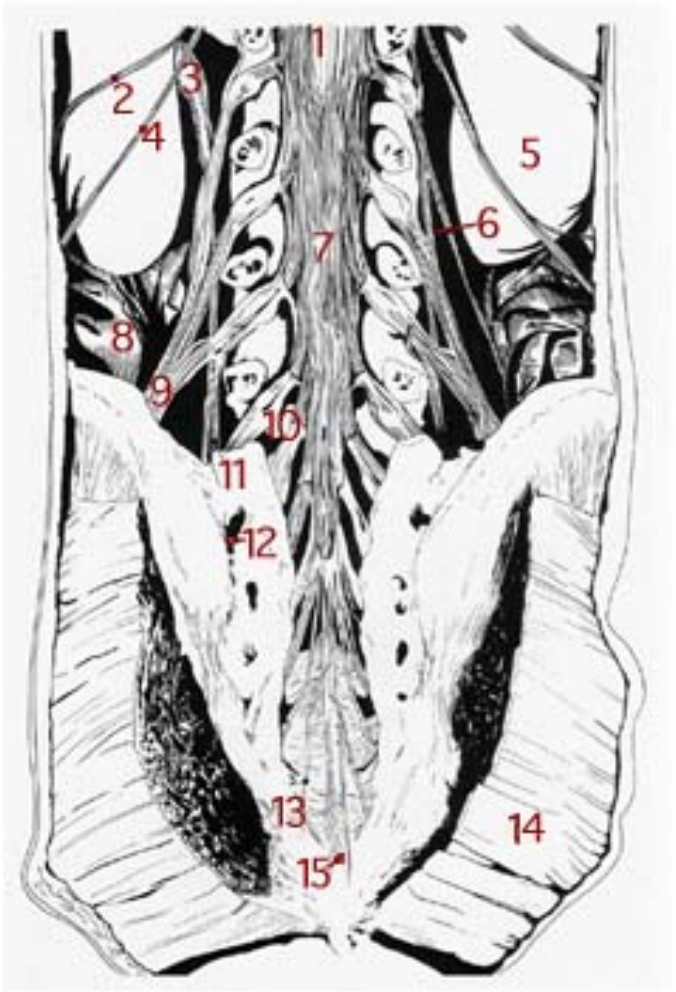
<u>To summarize</u>: upper thoracic segments (T1 thru T6) have a slender ventral gray horn, a lateral gray horn and a subdivided posterior funiculus.





1. Gracile tubercle
2. Cuneate tubercle
3. Posterior median sulcus
4. Posterior intermediate sulcus
5. Vertebral artery
   1st cervical spinal ganglion
6. Motor root of first cervical nerve
7. Cut surface of posterior arch of atlas

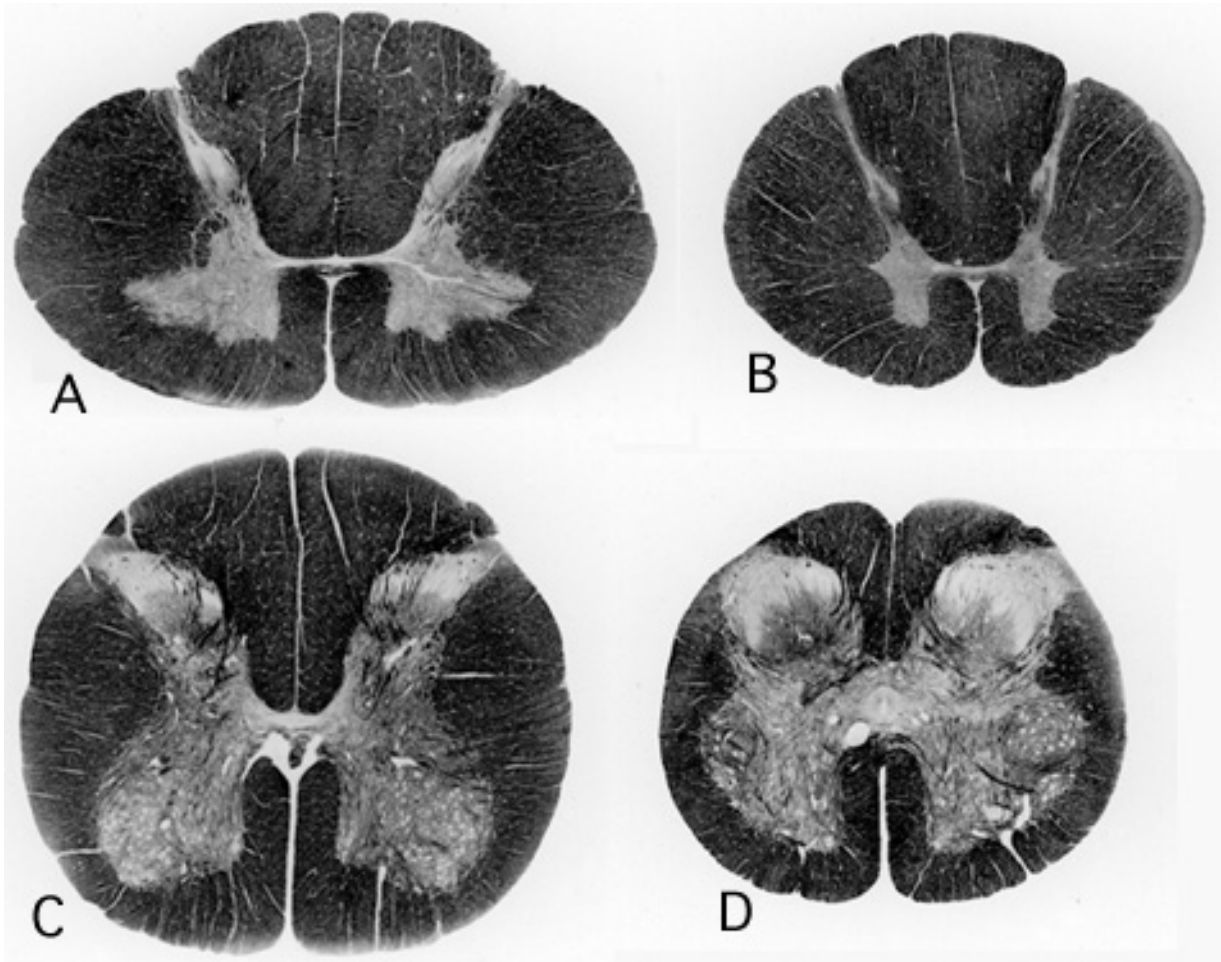
8. Cut surface of posterior arch of atlas **9.** Accessory nerve **10.** Cuneate fasciculus **11.** Gracile fasciculus **12.** Posterior lateral sulcus **13.** Denticulate ligament **14.** Cut edge of dura **15.** Dorsal rootlets of 5th cervical nerve **16.** Pia mater



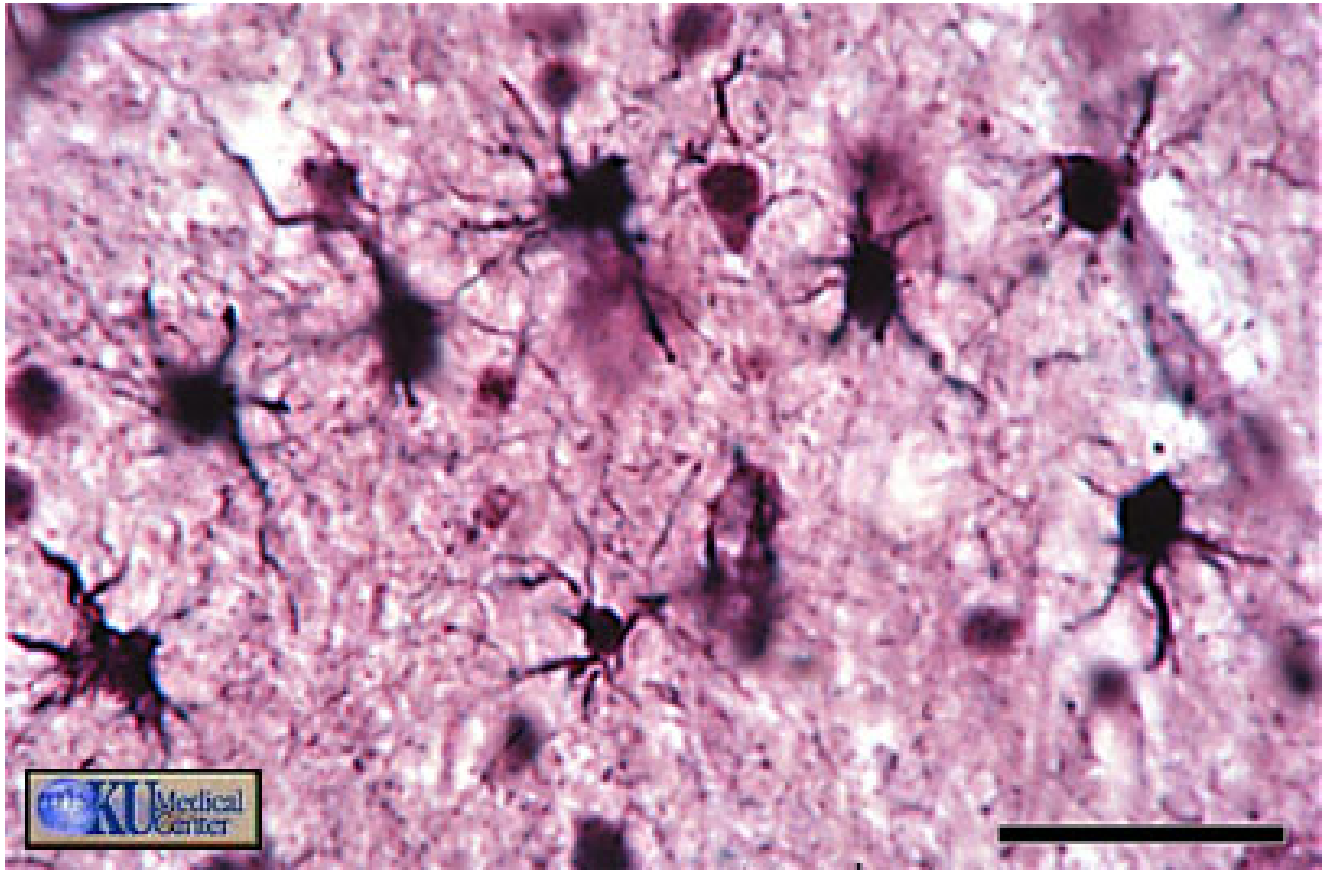
1. Conus medullaris
2. Iliohypogastric nerve
3. Pelviureteric junction
4. Ilioinguinal nerve
5. Posterior surface of right kidney
6. Lateral cutaneous nerve of thigh
7. Cauda equina
8. Descending colon

9. Femoral nerve **10.** 5th lumbar spinal nerve ganglion **11.** Obturator nerve **12.** 1st sacral dorsal foramen **13.** Coccygeal nerve **14.**Gluteus maximus muscle **15.** Termination of filum terminale

1-9 Transverse sections of spinal cord at different levels: A. Cervical region, B. Thoracic region, C. Lumbar region, D. Sacral region.



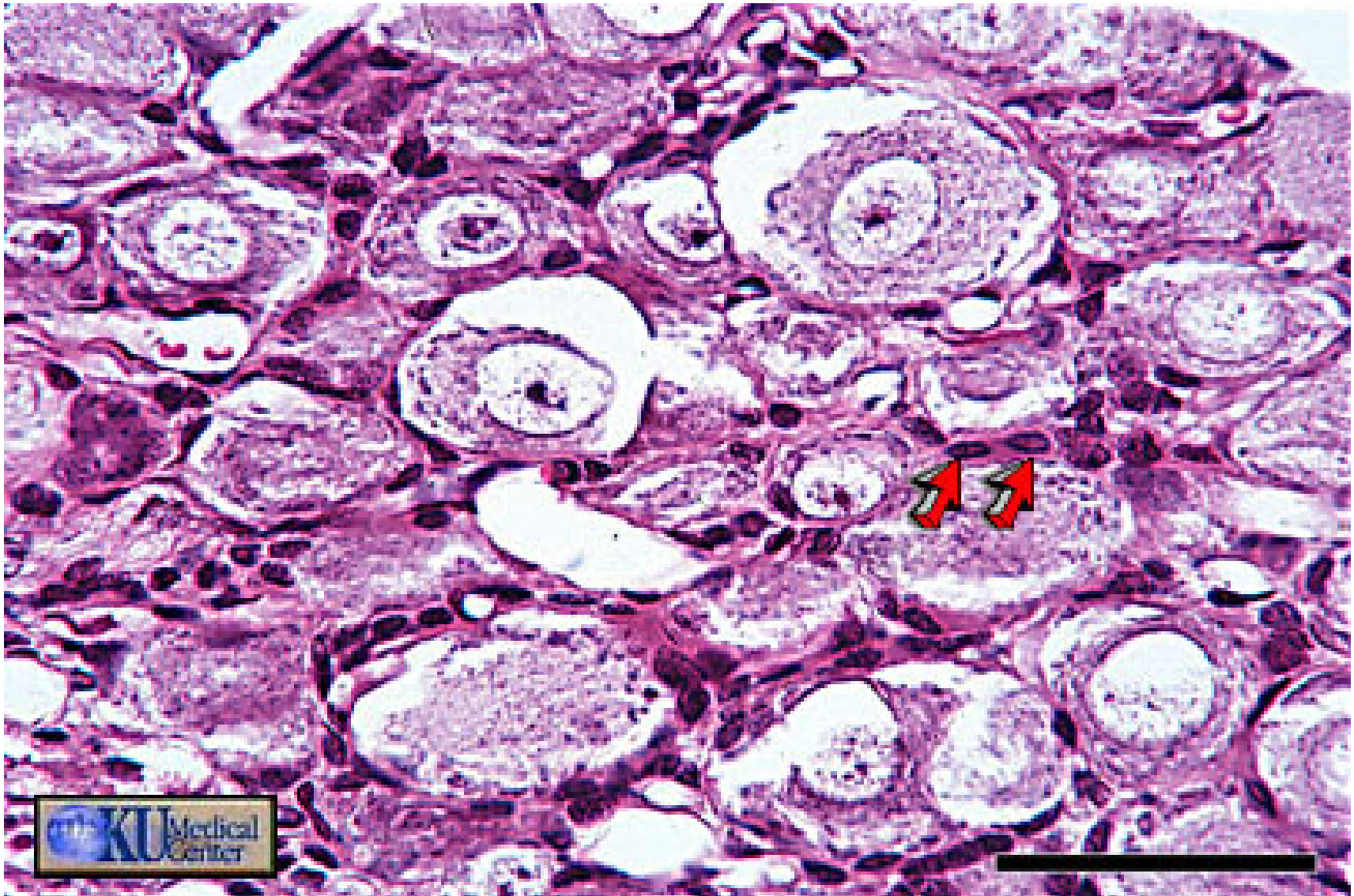
1. Dorsal (posterior) median sulcus **2.** Dorsal (posterior) intermediate sulcus **3.** Posterior median septum **4.** Posterior funiculus **5.** Posterior lateral sulcus **6.** Substantia gelatinosa **7.** Dorsal (posterior) gray horn, nucleus proprius **8.** Lateral funiculus **9.** Thoracic nucleus (dorsal nucleus of Clarke) **10.** Intermediolateral gray column **11.** Ventral (anterior) gray horn **12.** Ventral funiculus **13.** Anterior median fissure **14.** Ventral white commissure **15.** Intermediate gray substance **16.** Medial longitudinal fasciculus **17.** Anterior corticospinal tract **18.** Tectospinal tract **19.** Reticulospinal tract **20.** Vestibulospinal tract **21.** Spinotectal tract **22.** Anterior spinocerebellar tract **23.** Rubrospinal tract **24.** Spinothalamic tract **25.** Lateral corticospinal tract **26.** Posterior spinocerebellar tract **27.** Cuneate fasciculus **28.** Gracile fasciculus

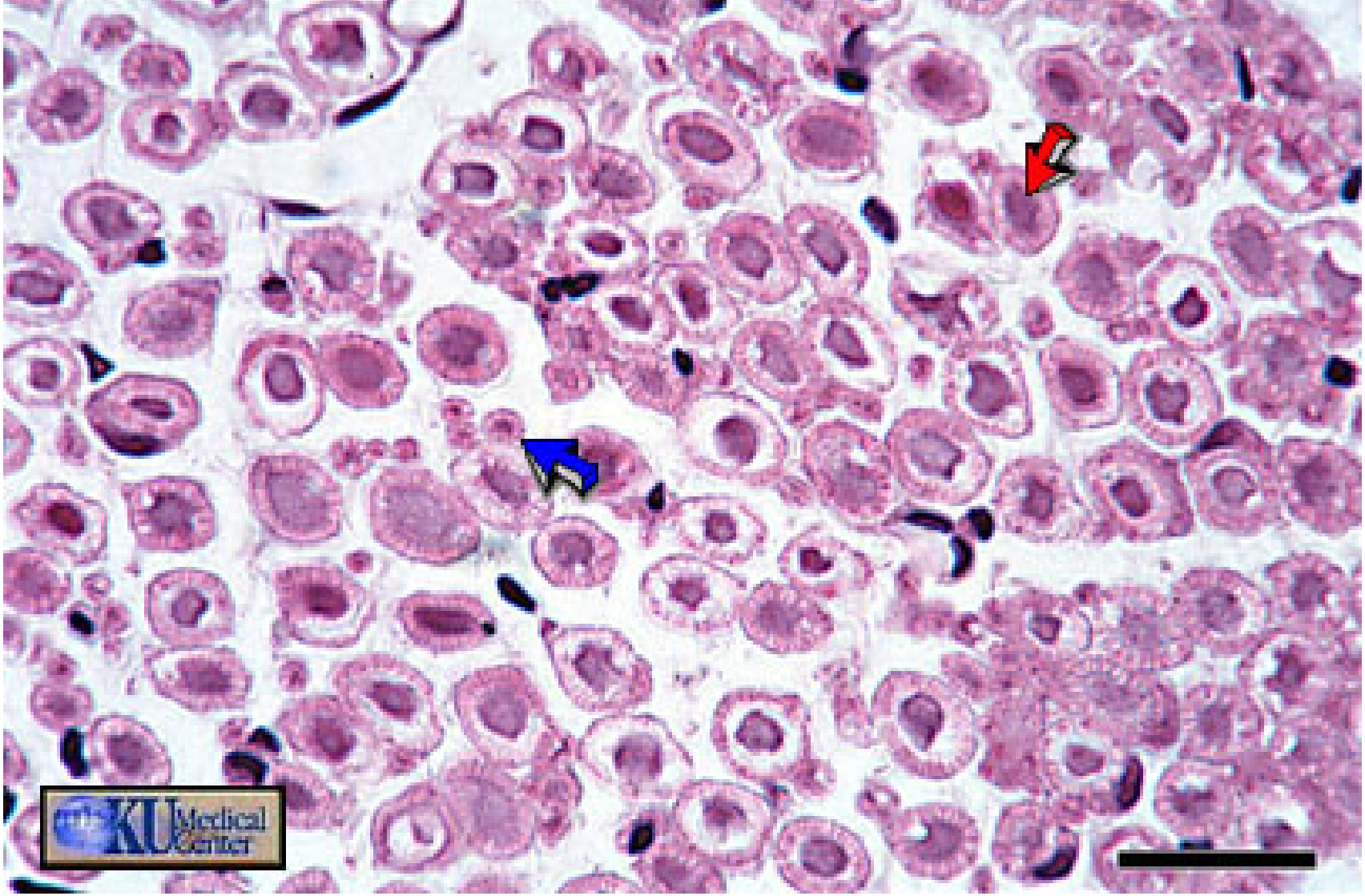


Slide 15 Astrocytes

Astrocytes are star-shaped glial cells of the CNS that have long processes. Many of these **processes extend to blood vessels where they expand and cover much of the external wall. The expanded endings of the astrocyte processes are known as end-feet**. While the blood-brain-barrier is formed by tight junctions between endothelial cells, **the end-feet function to induce and maintain the blood-brain barrier.** In pathology following stroke the relationship of end-feet to the endothelial cells is altered leading to disruption of the blood-brain barrier and subsequent leakage.

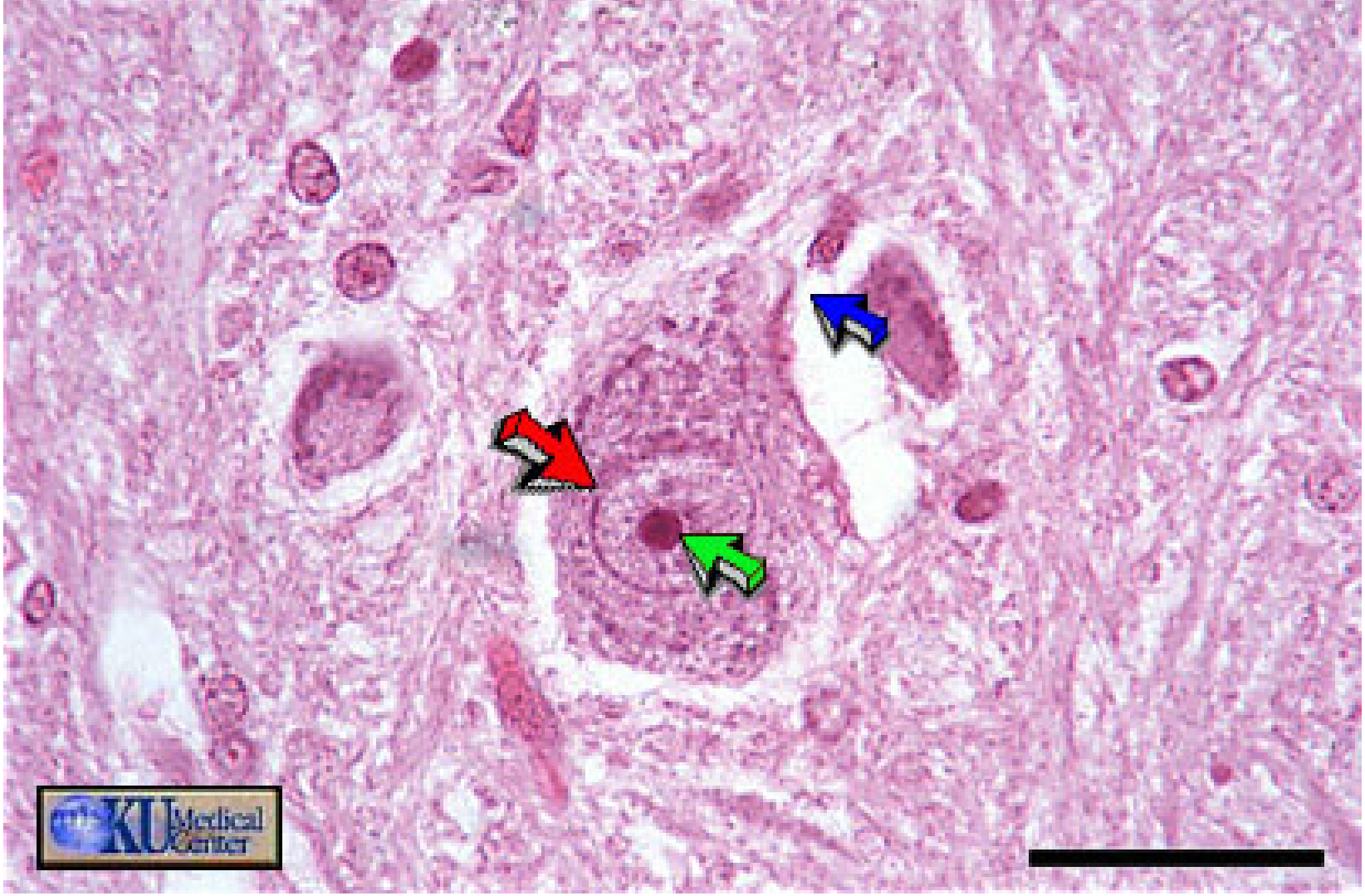
Satillite cells of the Glia of the dorsal root ganglia





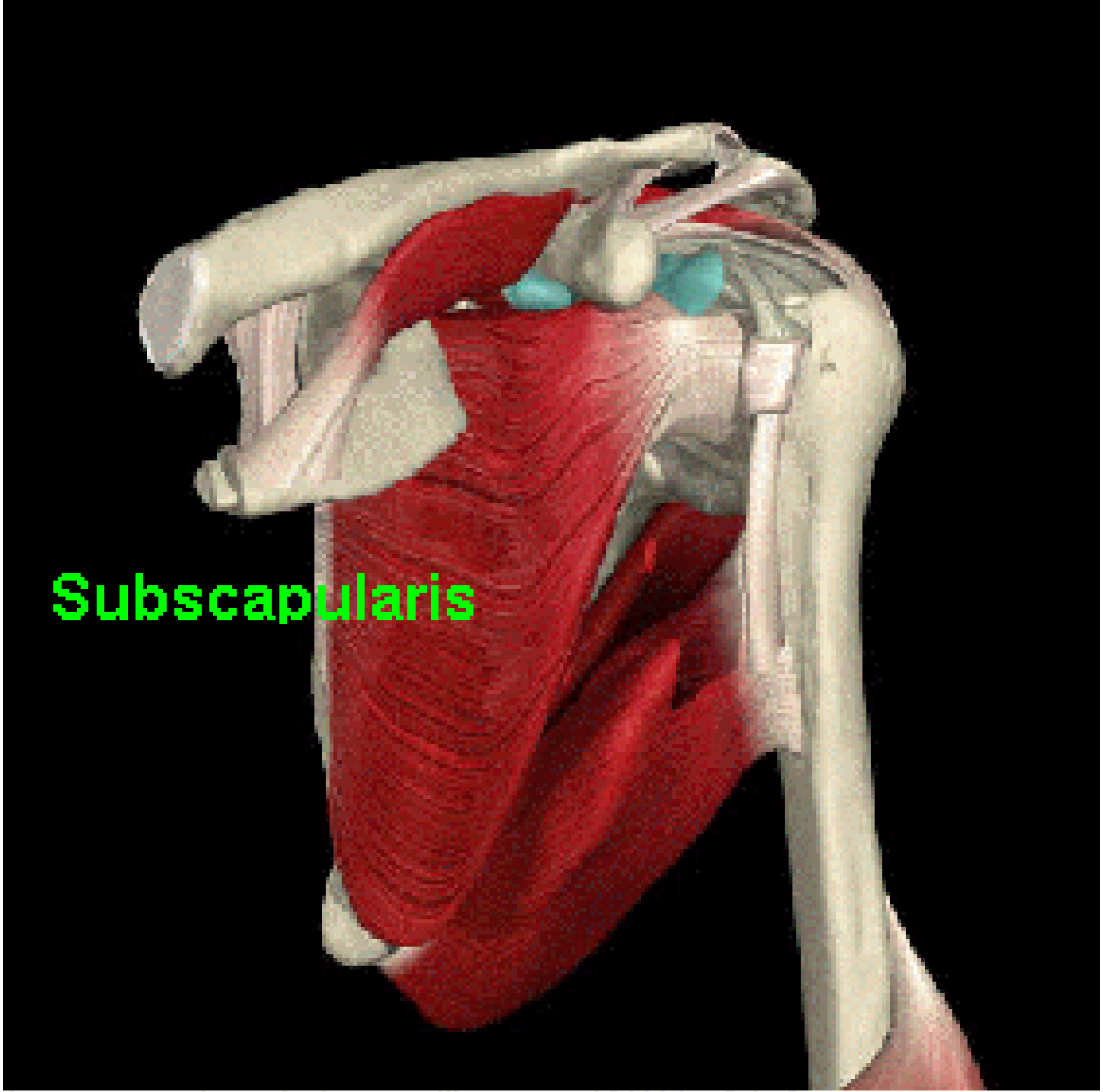
Peripheral Nerve

In cross section, the dark axons are clearly seen within the myelin sheath (red arrow). Notice also the smaller B fibers (blue arrow). They too are myelinated.



Gray Matter

Gray matter within the spinal cord contains many nuclei such as this multipolar motor neuron. Notice the nucleolus (green arrow) within the nucleus (red arrow) and what appears to be an axon or dendrite (blue arrow).


Subscapularis